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The Official Publication of the Society of Plastics Engineers, Inc.

EDITORIAL DEPT.
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WHAT TO LOOK FOR . . .

at the 9th National Plastics Exposition • this issue – page 424

the big news story for suppliers and users of elasto-plastic components!

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TEXIN, a newly-developed urethane elastomer "green stock" resin supplied in chopped particle form, is designed for those mass market industrial applications which require a highly-functional elasto-plastic material that can be simply processed with existing equipment by fast-cycle, low-cost methods.

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e-8

Typical minimum physical properties of two grades of TEXIN

Type	Specific Gravity	Bulk Factor	Hardness		Tensile Strength	Elongation at break	Tensile Modulus psi			Elongation Set	Tear Strength
			Shore A	Shore D			100%	200%	300%		
192 A Molding Grade	1.25	2.7	92-94	44-45	4400 psi	600%	1150	1550	2050	45%	300 lbs.
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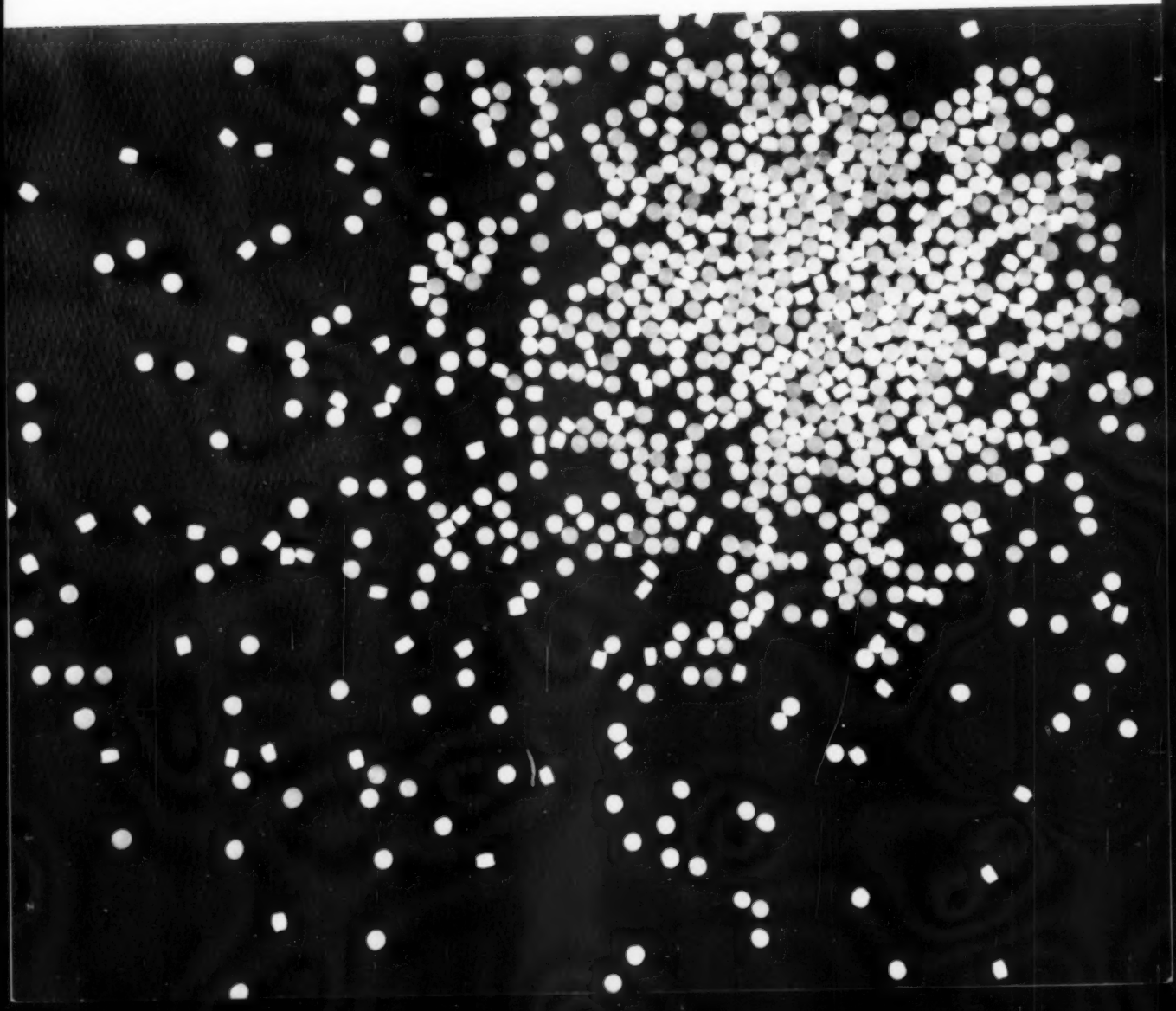

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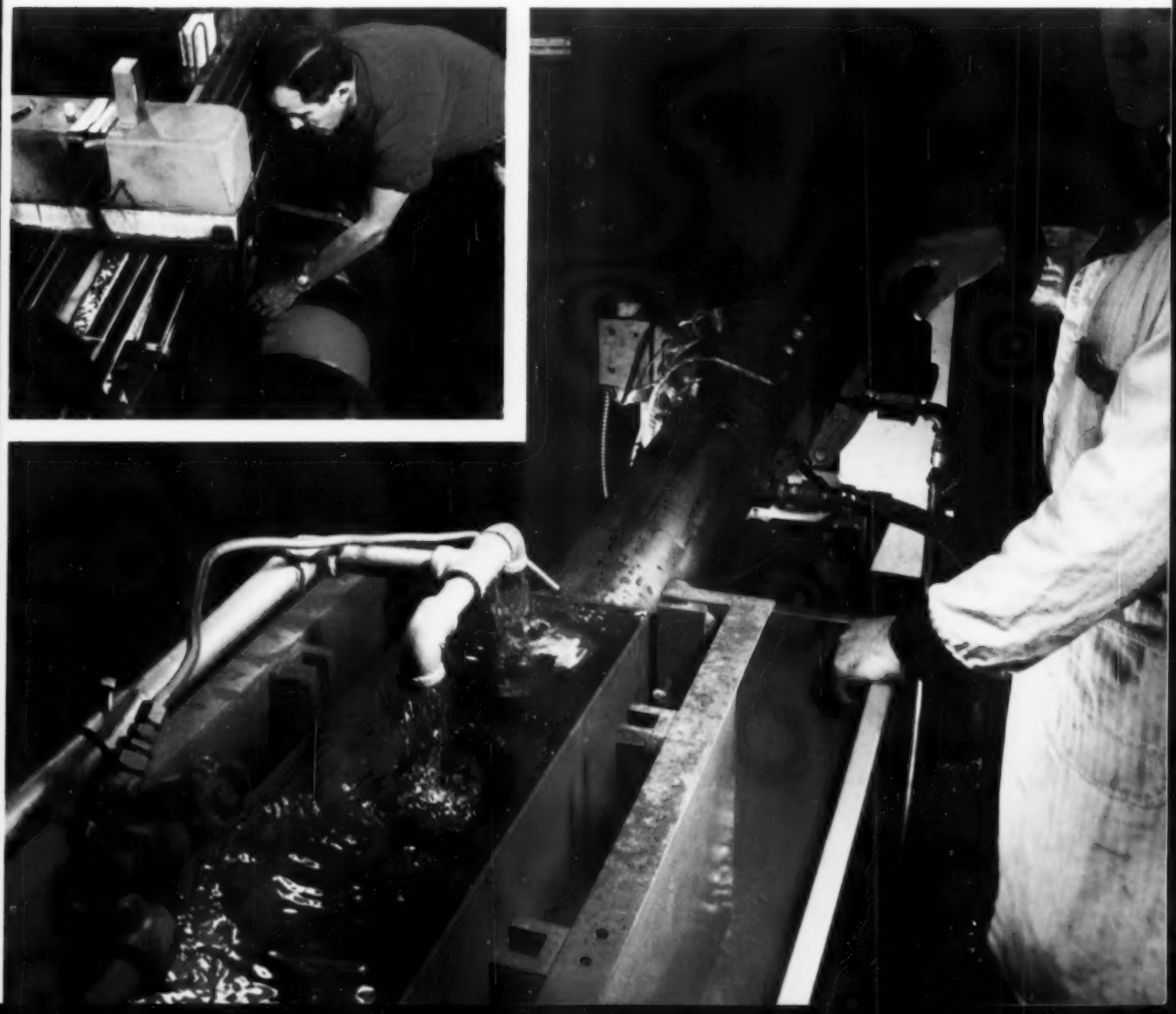

AMERIPOL POLYETHYLENE HAS SUPERIOR PROPERTIES THAT WILL PAY OFF IN YOUR PRODUCTS

	ASTM		AMERIPOL GRADE NO.		
Physical Property	**Units**	**Method**	**32**	**34**	**35**
Density	g/cc	D648-56	0.95	0.95	0.95
Molecular Weight	———		50,000	80,000	100,000
Melt Index (condition E)	g/10 min	D1238-57T	0.1-0.2	0.04-0.08	0.001
Flow Index (a) (condition F)	g/10 min	D1238-57T	24.0-28.0	8.5-9.3	4.0-5.6
Intrinsic Viscosity	———	D1601-58T	2.3-3.0	3.1-3.7	3.8-4.8
Vicat Softening Temperature	°C	D1525-58T	119	121	122
Ultimate Tensile Strength, 20 ipm	psi	D412-51T	2250	2450	2700
Tensile at Yield, 20 ipm	psi	D412-51T	3450	3450	3450
Elongation, 20 ipm	%	D412-51T	120	320	560
Impact Strength (b)					
⅛ x ½ bar	ft/lbs				
	in notch	D256-54T	19	31	36
¼ x ½ bar	"	D256-54T	8	17	24
½ x ½ bar	"	D256-54T	0.9	1.9	4.3
Stiffness in Flexure	psi	D747-50	115,000	115,000	120,000
Hardness	Shore D	D1706-59T	60	60	60
Environmental Property					
Environmental Stress Cracking (c)					
With Anti-oxidant	hrs.		65	445	>800
Without Anti-oxidant	hrs.	D1693-59T	40	230	500
Thermal Embrittlement (d)					
With Anti-oxidant	hrs.	(d)	185	>1000	>1000
Without Anti-oxidant	hrs.	(d)	70	95	700

(a) Cutoff on flow index test made at the end of 30 seconds.
(b) The impact strength test result is greatly influenced by sample size.
(c) ASTM Standard on Plastics, D1693-59T Method of Test for Environmental Stress Cracking of Type I Ethylene Plastics. This test, which has been adopted for Type I Ethylene Plastics is used herein for Type III in the absence of an official method.
(d) This test employs compression molded specimens, 5" x 0.25" x 0.05", three of which are wrapped and clamped around a ¼" mandrel. The apparatus is inserted in a nitrogen blanketed test tube which in turn is placed in an aluminum block @ 100°C. The value reported is the time until two of the three samples crack.

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It's easy. A call to Goodrich-Gulf Technical Service is all that's needed. An experienced sales engineer will come out to your plant and help you select the right grade of Ameripol for your product. You'll find that Goodrich-Gulf has the technical know-how to handle every aspect of your high density polyethylene needs – from application and production to shipping and storage. See how better products start with Ameripol high density polyethylene – Write for your Ameripol Technical Data file now!

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SPE JOURNAL
VOL. 17 • NO. 5
MAY 1961

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REGIONAL TECHNICAL CONFERENCE

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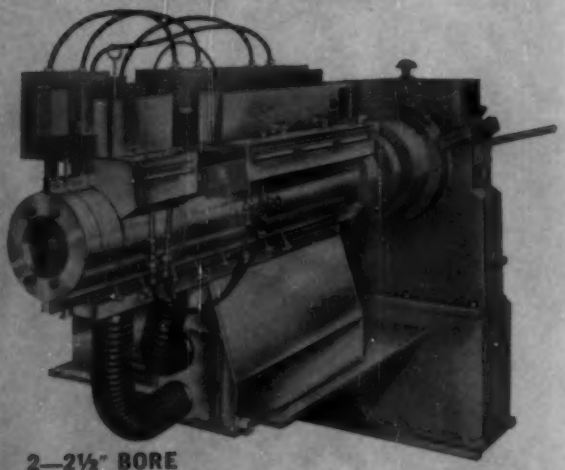

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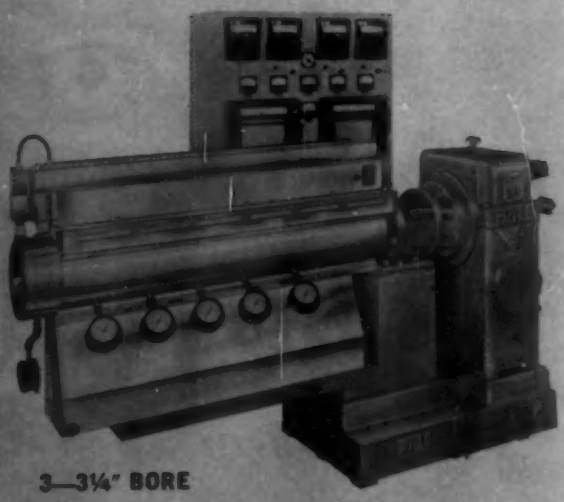

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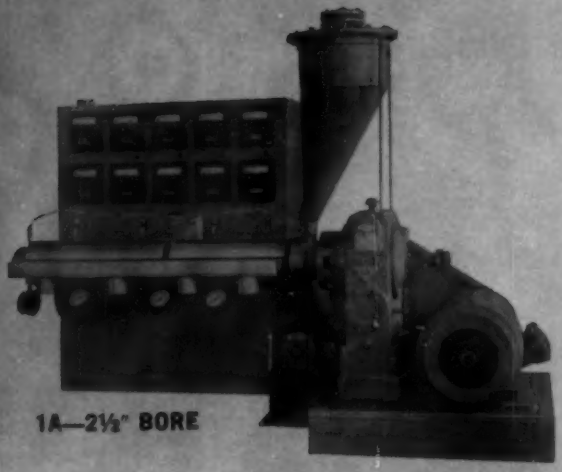

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EDITORIAL

A Progress Report

Since January 1961, two issues (numbers) of SPE TRANSACTIONS have been published. For those readers of the SPE Journal who have "tuned in late," SPE TRANSACTIONS is a quarterly publication devoted to fundamental developments in polymer theory science and engineering.

Original estimates of subscriptions for the first year ranged from a low of 350 to a high of 750. At this writing, there are approximately 1000. And SPE TRANSACTIONS is truly a global publication. Subscriptions have come in from South Africa, Yugoslavia, China, the USSR, Spain, Switzerland, Brazil, Argentina, Germany, Belgium, Canada, Australia, Israel, England, France, Italy, Japan, Mexico, The Netherlands, Phillipines, Scotland, and Sweden. Foreign and domestic subscriptions continue to come in daily.

It's difficult to start a magazine. There's not much you can do in the way of market research. You plan, you estimate, then you do. Not until the issue is out do you have any idea of its success. It appears now that the men who conceived the idea of such a publication did, in fact, anticipate a genuine need.

Manuscripts of high enough caliber and enough of them were also a source of concern to those participating in the early deliberations. However, Professor Herman F. Mark, member of SPE's Publications Committee, remarked at one meeting that "everything in this field polymerizes, including the literature." This appears to have been somewhat prophetic. Prominent polymer scientists and engineers in this country have submitted manuscripts for possible publication in TRANSACTIONS. In addition, manuscripts have been coming in from Paris, Leningrad, and Durban.

Where is SPE TRANSACTIONS going? In the words of Professor Mark, it will polymerize, get bigger. Instead of approximately 50 pages an issue, it will contain possibly 80 pages. The next step might be to publish 6 times a year instead of 4, then monthly.

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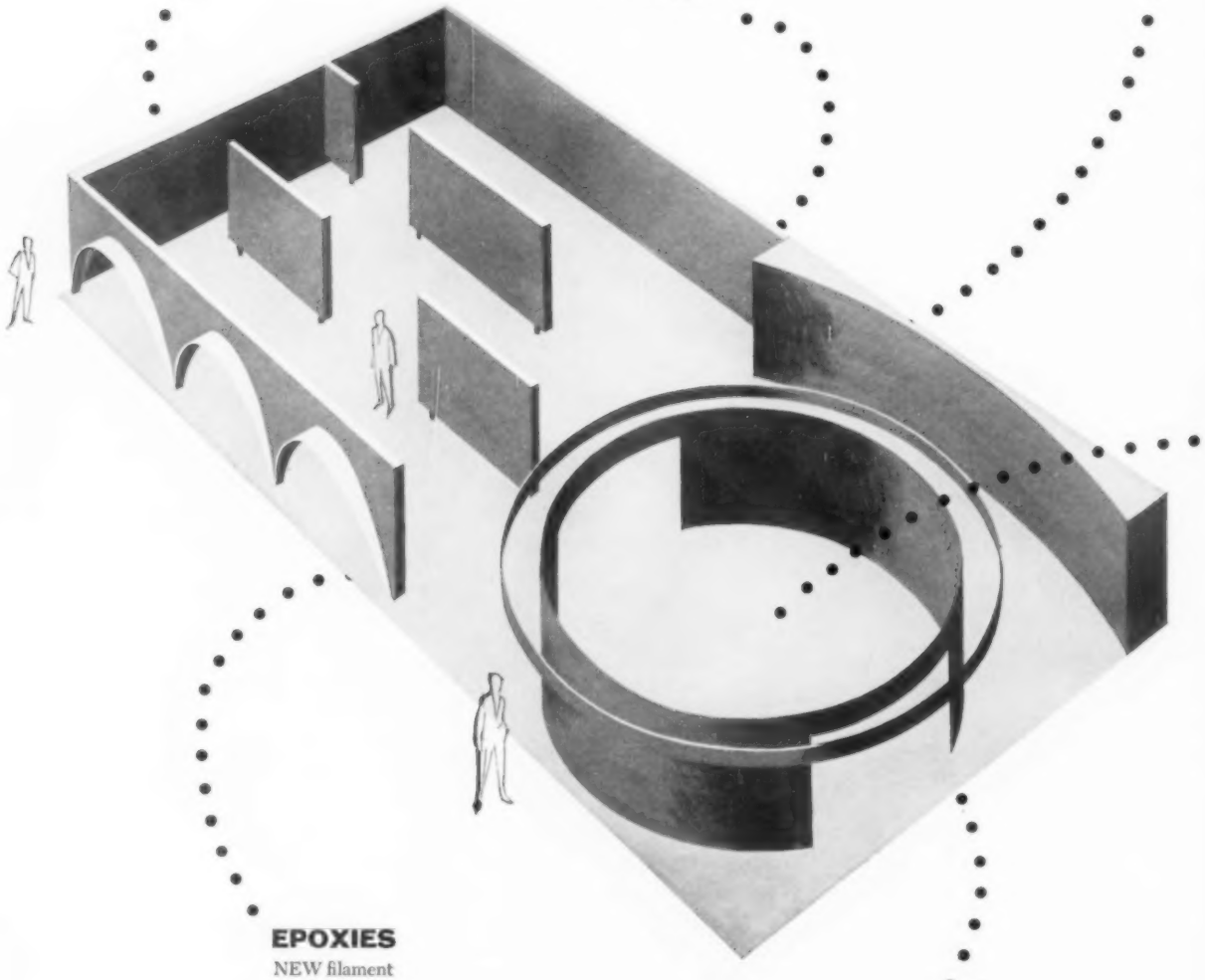

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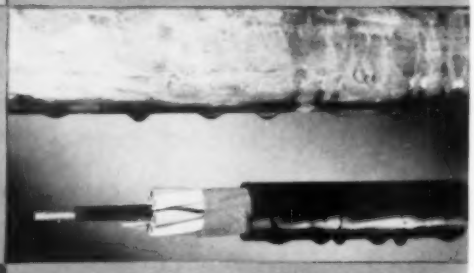

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Letters

Plastics and Stuff . . .

Dear Sir:

There is a sentence in the editorial "Plastics and Stuff . . ." in the March SPE Journal with which I take issue. The sentence is "It is virtually impossible to obtain burning rate data on cellulose-based materials." My experience indicates that it is easy to obtain such data.

We have measured the burning rates of hundreds of samples of cellulose acetate, cellulose acetate butyrate, cellulose propionate, ethyle cellulose, and cellulose nitrate plastics by ASTM methods D 568, D 635, and D 1433. I am sure that D 1692 could also be used. These tests on cellulose-based plastics are so easy to make that one operator can make approximately 100 measurements in one day.

As a matter of fact you contradict yourself in this same paragraph when you state that "cellulose acetate has a burning rate of 0.5 to 2.0 inches per minute."

Measurements of the burning rates of products made of cellulose such as cotton fabric, canvas, paper, boxboard, fiberboards, building sheets, plywood, wood, etc. are made by methods designed for these materials. It seems that any definition that could cover cellulose-based materials will not help.

If you meant cellulosic materials such as lumber and paper, you would still be wrong. The burning rates of wood and paper are easily measured and it is done everyday. In fact redwood is used as the standard of reference in the well-known Underwriters Laboratory Tunnel Test. Burning rates of woods, papers and fabrics are available in published literature.

It has been my experience that the burning rates of most (not all) plastics are the same order of magnitude as those of paper and cotton fabrics when the comparison is made with pieces of the same size and thickness and by the same test method.

Your editorial was excellent and hit a major problem in plastics. I am glad you wrote it and am saddened by this one sentence. I suggest that an editorial note be published stating that it was in error and that the burning rates of wood, cotton, paper, and cellulosic materials which are not considered harmful because of their burning rates are not markedly different from that of most plastics when tested by comparable methods with pieces of comparable dimensions. Some plastics have much lower burning rates and some are self-extinguishing.

Get down from your ivory tower, Mr. Editor, and eat crow with the rest of us poor common mortals (literaturely speaking).

Frank W. Reinhart, *Chairman*
Editorial Advisory Board, SPE

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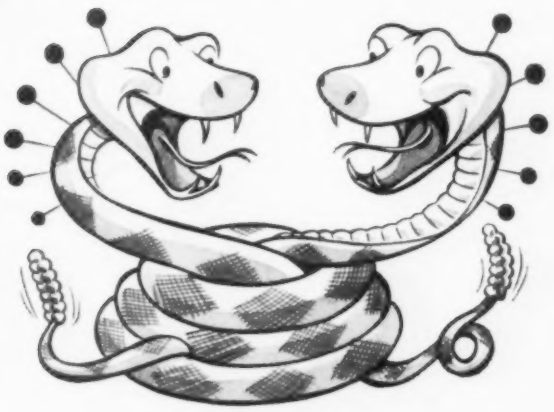
CROSSLINKING AGENTS



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PMS has been supplying these great companies and many more for years with their plastic color requirements. Always the leader in the field, PMS is the company that pioneered the moisture proof unit, micro milling, clean color and marble-mix — many of which have been copied by our competition (we bow to their flattering respect for our products and ability) but never equaled.
Symbol of the ultimate in dry colorants for every type of thermoplastic . . . and color paste dispersions and Gel Coats for polyester and Epoxy resins. Choice of the industry's Leaders who
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PLASTIC MOLDERS SUPPLY CO.
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Offices and Plants
Chicago, Illinois; Fort Worth, Texas; Norwalk, Ohio; Worcester, Mass.

Write today
for PMS Brochure

Letters

Editor's Note

Touché. We should have gone to the National Bureau of Standards for our burning rate data on cellulosics.

Dear Sir:

In the editorial of the March 1961 issue of the SPE Journal you made reference to a publication entitled "Plastic Foams—Storage, Handling, and Fabrication."

Will you kindly advise us as to where we might obtain a copy of same.

I. M. Olsen, *President,*
Industrial Metal Abrasives Co.

Editor's Note

This is a publication of the Manufacturing Chemists Association (MCA), Washington, D. C.

Reinforcing PVC

Dear Sir:

In the Newsletter of the SPE Journal for March 1961 mention was made of reinforcing rigid poly(vinyl chloride) sheet by the application of a special polyester resin and a glass fiber reinforcement.

As producers of poly(vinyl chloride) resin and of rigid PVC sheeting we are interested in obtaining further information concerning this method and would appreciate any help you could give us. Of particular interest would be the name of the British producer of the special polyester resin.

Editor's Reply

The company is Artrite Resins, Ltd., London.

Casting with Epoxies

Dear Sir:

In your SPE Journal, March 1961, we read with interest the article, "Casting to Close Tolerances With Unfilled Epoxy Resins."

We are in dire need of an epoxy resin for producing a clear casting for embedment of a variety of items.

In this article no particular emphasis was placed on formulation, except the mention of epoxy-diethylene triamine and references 2 and 3.

Can you give us some specific information on the manufacture of the epoxy-diethylene triamine and possibly a reprint of the 2 and 3 references?

We have exhausted all our known sources and have not obtained any specific information on a clear embedment by casting.

Any assistance would be greatly appreciated.

Robert H. Pasley,

Executive Vice-President
and General Manager
Pasley's Plastic Products

Editor's Note

Mr. Pasley was referred to Mr. Byron Nelson, one of the co-authors of the above paper and to the DeBell and Richardson Co. in Hazardville, Conn., which company has done extensive work in embedment techniques.

Have an Opinion?

Authors and editors like to hear from their readers. If you have any comments, opinions, or reflections on any of the articles in this issue, which you believe should be publicized, just drop a line to the Editor, SPE Journal, 65 Prospect St., Stamford, Conn.

"NOW YOU TELL ME . . . THAT TOP-QUALITY, IMPROVED SANTICIZER® 409 PERFORMS AS WELL FOR 4¢ A POUND LESS!"

Check for yourself! Santicizer 409 matches the permanent plasticizing performance of polymeric plasticizers that cost as much as 4 cents a pound more. Outperforms equal-priced polymeric plasticizers in many quality vinyl products.

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Superior Retention of Elongation .....
Low Odor
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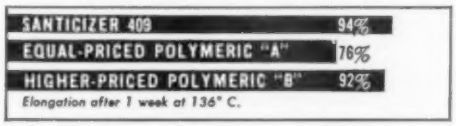

Elongation after 1 week at 136° C.

REFRIGERATOR-DOOR GASKETS

Superior Resistance to Styrene Mar .....
Low Odor
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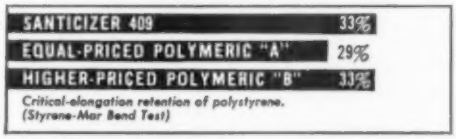
STYRENE-MIGRATION RESISTANCE

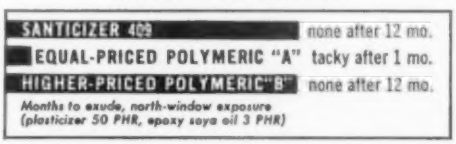


Critical-elongation retention of polystyrene. (Styrene-Mar Bend Test)

FILM AND COATED FABRIC

Superior Window Compatibility .....
Excellent Electrical Properties
Low Migration to Rubber
Better Color
Low Odor

WINDOW COMPATIBILITY



Months to exude, north-window exposure (plasticizer 50 PHR, epoxy soya oil 3 PHR)

SANTICIZER 409 IS BETTER THAN EVER

Process improvements built into our new multimillion-pound-per-year plant, now onstream at Everett, Massachusetts, have still further reduced color, taste, and odor of Santicizer 409—and its compatibility and permanence are even better, too.

Send today for your copy of Technical Bulletin PL-409.

COME TO BOOTH 1315
at the Plastic Exposition
New York Coliseum — June 5-9

- Check the performance of our brand-new polymeric plasticizers
- Find out what our new flame-retarding compounds can do for you
- Watch our lively demonstrations of processing and performance advantages

We'll be delighted to swap ideas with you!

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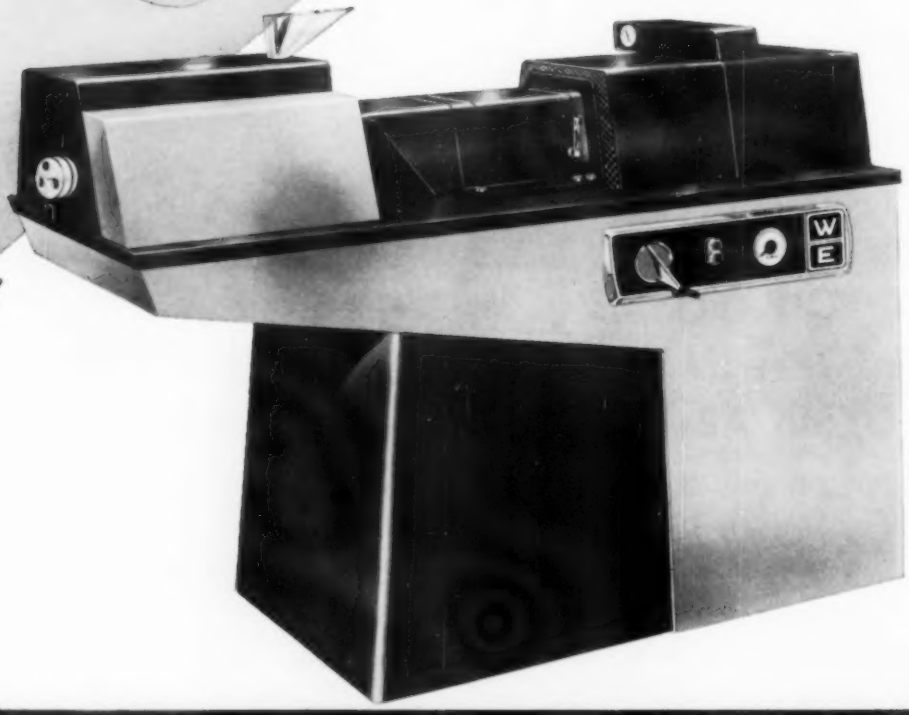
MONSANTO CHEMICAL CO.
Organic Chemicals Division
Plasticizer Council, Dept. 4409V
St. Louis 66, Missouri

A new tool for Science



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For the best in reinforced plastic boats...

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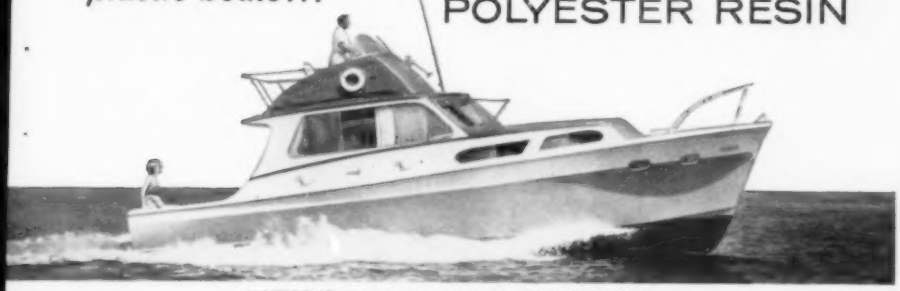

HATTERAS 41—Hatteras Yacht Co., High Point, N.C.

RHODES 19—The O'Day Corporation
Boston, Mass.

13' BOSTON WHALER—The Fisher-Pierce Co.
Rockland, Mass.

15' 7" MAG CAT—Magnolia Boat Co.
Vicksburg, Miss.

DUCK BOAT—Aluminum Boats & Canoes, Inc.
Princeville, P.Q., Can.

16' SEA QUEEN—Sea Fury, Inc.
Springfield, Mo.

17' REEFMASTER—Duratech Manufacturing Corp.
Peekskill, N.Y.

16' DEL MAR—Glasspar Co.
Santa Ana, Calif.

15' 5½" PIRATE—Span America Boat Company
Fort Dodge, Iowa

17' MARINE RAIDER—American Marc Inc.
Inglewood, Calif.

14' 5" MACKINAC—Wagemaker Boat Company
Cadillac, Mich.

ARISTO-CRAFT FUNLINER "17"
Atlanta Boat Works Atlanta, Ga.

17' ESCAPADE—Shell Lake Boat Company
Shell Lake, Wisc.

17' IMPELLA—Volvo Powered
Sabre Craft Boat Co. Tacoma, Wash.

32' GILL-NET FISHERMAN
Ron Rawson, Inc. Seattle, Wash.

17' SEA LANCER
Flare Fiberglass Boat Co. Lakeland, Fla.

Better boat builders across the nation and around the world are using RCI POLYLITE polyester resins for the ultimate in customer satisfaction.

Creative Chemistry... Your Partner in Progress

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"PLASTICS PEOPLE" DON'T BLUSH...

when they're processed with Barber-Colman Controls

Even minor off-color "blushing" is eliminated when injection molders and extruders are Barber-Colman equipped. Barber-Colman Controls offer true color and accurate form through precise temperature control. And now, you can indicate temperature or pressure measurements on only one instrument with Barber-Colman's new 400 Series Capacitrols. Simply flip a selector switch to indicate the temperature or pressure. Also, you can record any combination of temperature and pressure up to 24 points with the new Series 8000 Recorders. Barber-Colman's wide ranging automatic process controls are the first choice in the Plastics Industry. Contact your nearest Barber-Colman, Wheelco Industrial Instruments Division office or write direct for complete information.

SERIES 8000 INDICATOR/RECORDER
Any combination of temperature or pressure recording up to 24 points. Separate 11" scales, up to six high or low limit switches, electronic potentiometer, swing-out chassis.

SERIES 400 CAPACITROL INDICATOR
Pressure and Temp. selector switch, 6" scale, direct reading, high or low limits.

SERIES 400 CAPACITROL — more accurate 6" scale, no-contact Electronic Link, sensitive, reliable, plug-in chassis.

MODEL 297 5" SCALE CAPACITROL
Accurate, rugged dependable, no-contact Electronic Link, plug-in components.

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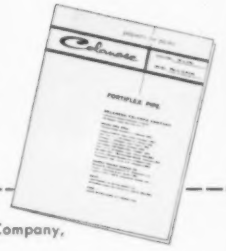
BARBER-COLMAN of CANADA, Ltd., Dept. Q, Toronto & Montreal • Export Agent: Ad. Auriema, Inc., N.Y.

CELANESE POLYMER COMPANY

Now...Two new Fortiflex resins for THIN-WALL PIPE

From Celanese—another big advance in plastic materials! Improved molecular architecture makes possible these two new Fortiflex pipe resins for pipe exceeding requirements of Department of Commerce Specifications CS 197-60. Both resins are approved by NFS for use with potable water.



Here's ease of processing and new economies for makers and users of plastic pipe!

Fortiflex BFX-31146 is designed to produce *non-marginal Type II pipe* which *more than meets* commercial standard specifications at minimum wall thicknesses. For example, walls as thin as 0.091" can be obtained with this resin in 1" I.D., Series 2, Type II pipe. And there's strength to spare for tough applications and rough service.

Fortiflex B45-30R-02 is designed to produce more flexible and coilable *non-marginal Type III pipe*, which also *exceeds* commercial standard specifications at minimum wall thicknesses. For example, minimum wall thicknesses of 0.075" can be achieved in 1" I.D., Series 2, Type III pipe made of this resin. This pipe can be bent around diameters of 28" *without kinking*. And it can be readily joined with plastic or metal fittings and clamps.

Pipe manufacturers will find these new Fortiflex resins extrude at extremely good output rates on conventional equipment. And, quite often, give more feet of pipe per pound of resin. Why not find out more about them? Mail the coupon for full details.

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Celanese Polymer Company is a Division of Celanese Corporation of America
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Celanese Polymer Company,
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Please send me a copy of Bulletin NP-46, on new Fortiflex Pipe Resins.

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are induction-heated and water-cooled for precise temperature control **/ have floating screw and self-cleaning valve for** flexible pressure control **/ are well instrumented for** optimum operator control.

They operate trouble-free around the clock and save money in terms of increased production and less scrap on extrusion coating, laminating, blown or flat film production. 1½" to 8" ... Up to 10,000 psi ... 20:1 to 29:1 L/D ratios. Output Rates to 2000 Lbs/Hr on extrusion coating. Lab models, too. **Write or call for Bulletin HK-10.**

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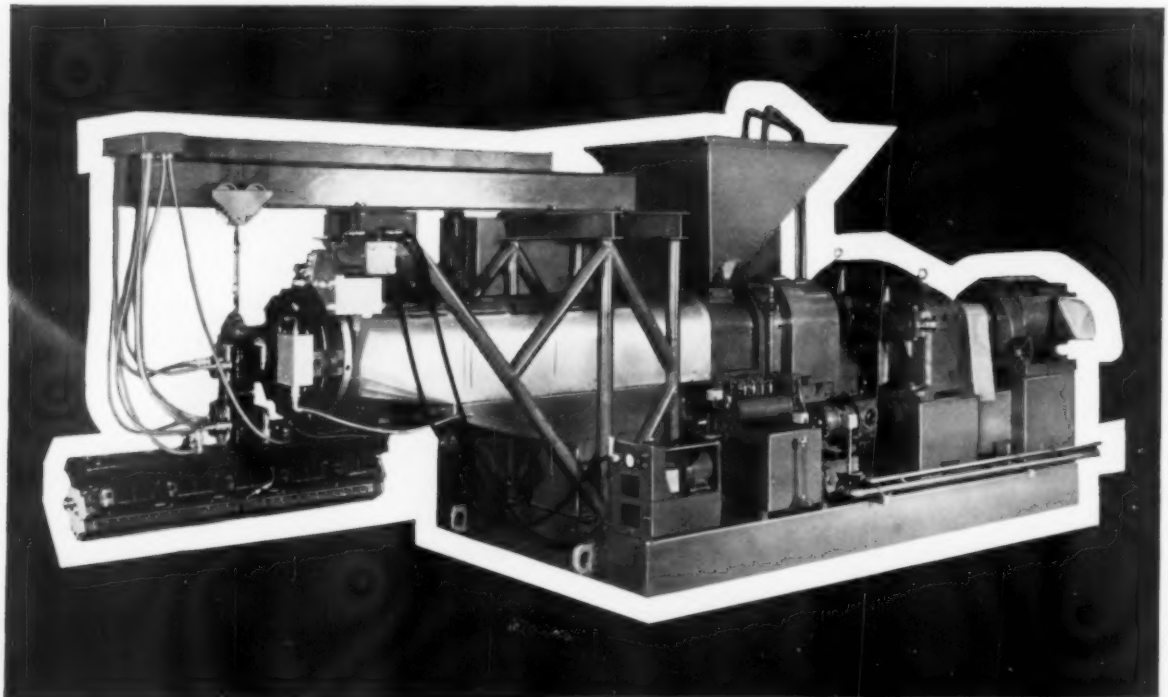

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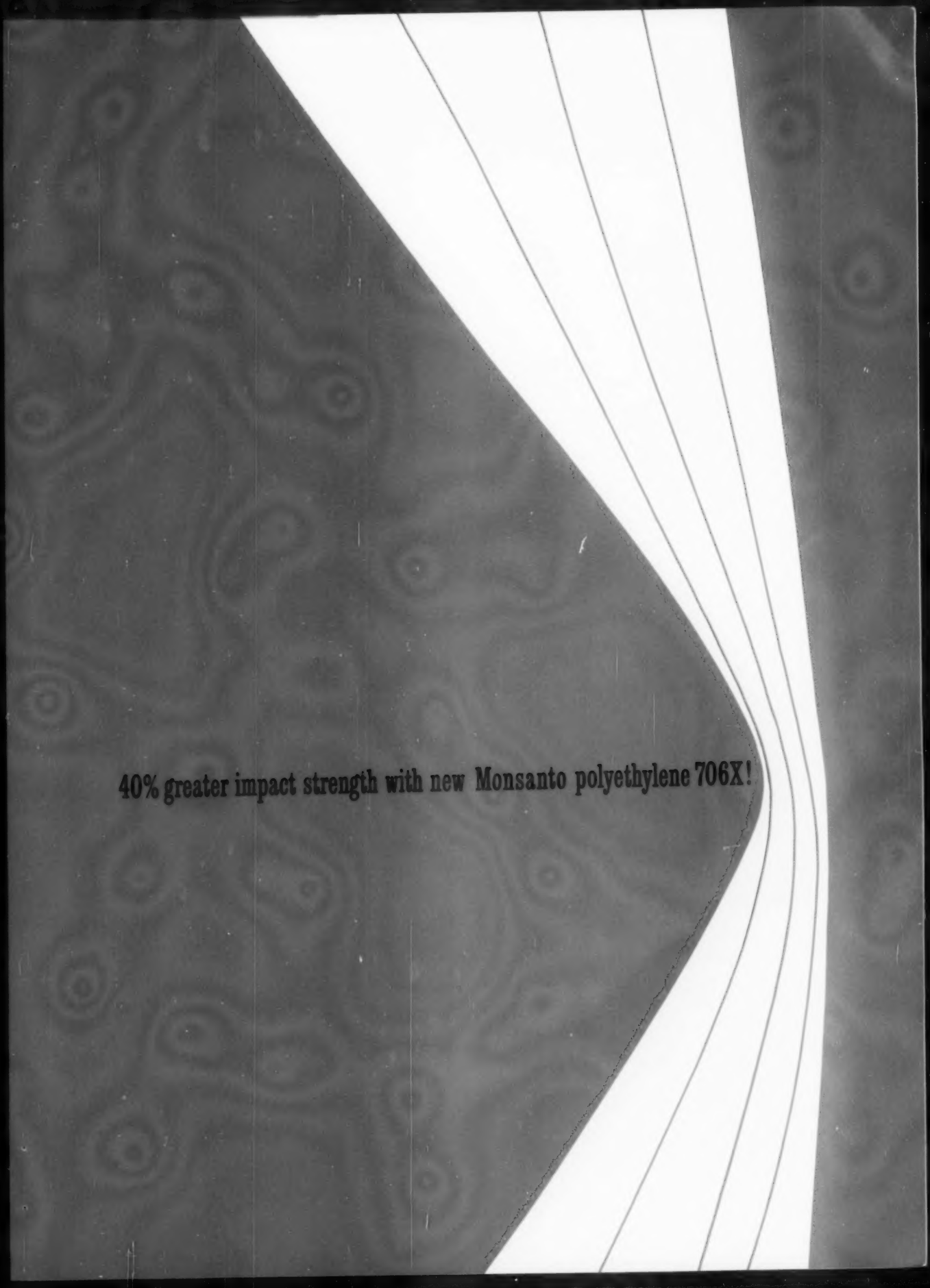
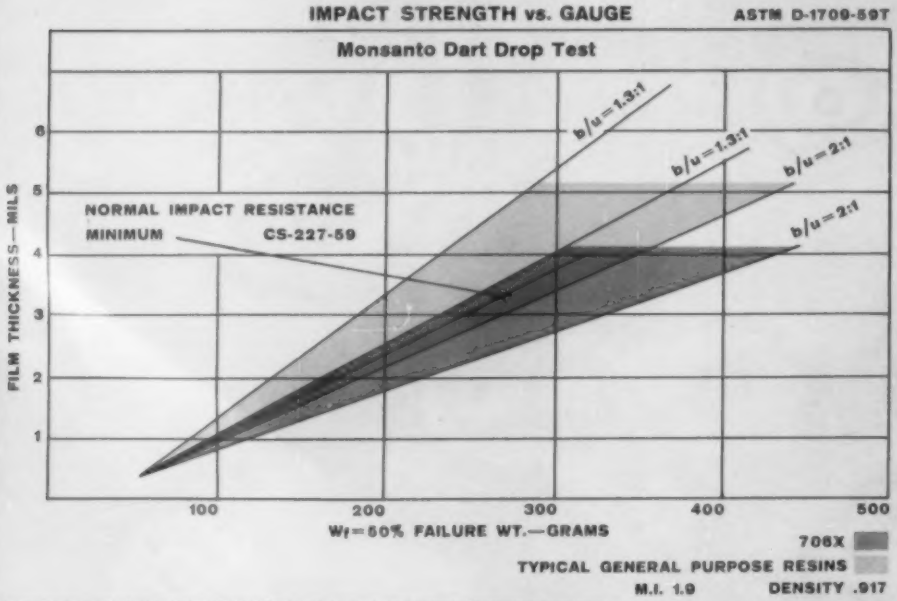

40% greater impact strength with new Monsanto polyethylene 706X!

MONSANTO BRINGS OUT THE BEST IN PLASTICS

ANNOUNCING POLYETHYLENE 706X, a new super high impact film resin, for industrial packaging, construction and agriculture... *at no increase in price!* Film extruded from 706X has demonstrated 40% higher impact strength than film from any general purpose resin in the drop-dart test (See Chart). It is available in 4 degrees of slip, has the same physical appearance as regular 706, the same unique blend-to-blend, bag-to-bag uniformity, the same excellent and consistent processability, *and the same price!* Send coupon below for new Technical Service data sheet on MP 706X, to Monsanto Chemical Company, Plastics Division, Room 819, Springfield 2, Massachusetts.



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MONSANTO CHEMICAL COMPANY, Plastics Division. Room 819, Springfield 2, Massachusetts.

Please send me:

- ☐ 706X Data Sheet – Film and Resin information
- ☐ Names of leading suppliers of film made with 706X

NAME ..... TITLE .....
COMPANY .....
ADDRESS .....
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MONSANTO

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SPE JOURNAL NEWSLETTER

reading time
1 minute

Ablation of Reinforced Plastics

Reinforced plastics for high temperature applications may get a boost as a result of work done on material combinations for rocket nose cone use (page 429). Some results: As density goes up, ablation qualities improve; When laminations are arranged in a fashion other than parallel to gas flow, the ablation process is improved; resin content also influences laminate properties.

Cracking of Plastics

A previously unreported cause of cracking in plastics has recently been reported. Spontaneous cracking between spherulite (radial crystal growths in polymers) boundaries occurs during rapid crystallization. The discovery is a result of research aimed at establishing the optimum conditions of time and temperature of melt for spinning polypropylene fibers.

Epoxy Wheels for Tanks

Army tanks will be lighter in the future, thanks to reinforced plastics. Firestone Tire & Rubber Co. is developing glass fiber reinforced epoxy tank wheels which will reduce the weight of a typical tank by more than 2000 pounds. The RP wheels are expected to replace the conventional steel wheels on a tank. Each wheel is 7½ inches wide and nearly 25 inches in diameter.

New Polymer Vocabulary

Current studies of network polymers may shed more light on why and how polymers swell. Research conducted by Alfrey and Lloyd at Dow Chemical Co. considers the topology of molecular chains as well as the linear chain elements. The current studies also will lead to a new vocabulary for the polymer chemist. Examples of future polymer chemists' lexicon: Ghost networks, network entanglements, wasted loops, and network junctions.

Self-Sticking Urethane

Flexible urethane foam with self-adhesive backing is available for a wide variety of cushioning, insulating, and sealing applications. Made by Air-O-Plastik Corp., the pressure-sensitive foam adheres to any clean, dry surface. Big market now is weather stripping, though other applications may be in gasketing, case liners, display items, and sound deadeners under car hoods.

THAT EXTRA TOUCH OF GRACE: Market Development

Whether it's your new product idea or ours, it always sounds great at first blush. To be sure it is, Grace will check it out (in the strictest confidence) with jobbers, buyers and consumers. This program to develop new saleable end uses for modern thermoplastics is one of the 10 major services available to Grace customers as part of the Grace Service Plan. To the many manufacturers who have successfully used this service, it is one more proved example of that extra touch of Grace.

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HIGH DENSITY POLYETHYLENE, LOW AND MEDIUM DENSITY POLYETHYLENES, POLYSTYRENES.

GRACE
PLASTICS

Why the MOLDER

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D-M-E Standard Mold Base Availability Cuts Production Costs!

Using D-M-E Standard Mold Bases and component parts, you can develop greater production flexibility . . . your way to greater production savings!

D-M-E Standard Mold Bases and components are carried in stock at your local D-M-E Branch ready for quick delivery . . . delivery when you need it! With D-M-E you eliminate waiting, cut downtime, reduce maintenance, reduce your inventory and maintain production schedules.

Whether for injection or compression molding, D-M-E Standard Mold Bases enable you to work with one single reliable source. This one-call, immediate delivery service can help you to cut production costs . . . and increase profits!

MOLD DESIGNER: D-M-E standard components are fully interchangeable: Replacements can be made without special fitting or reworking. D-M-E enables you to work with greater freedom by providing a selection of over 7,000 catalogued mold base combinations. And D-M-E Master Layouts enable designers to devote more time to cavity layout.

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FREE CATALOG

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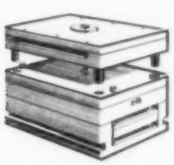
61-B-P



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A PREVIEW — the Ninth

SPI's NATIONAL PLASTICS CONFERENCE PROGRAM

At The Hotel Commodore, New York City

Registration — Monday, June 5, 1961

1:00 P.M.—Hotel Commodore

Tuesday, June 6, 1961

9:30 A.M.—12:00 Noon

Plastics in Building
Plastics in Communications
New Developments in Plastics Machinery
SPI Thermoplastics Structures Division

Wednesday, June 7, 1961

9:30 A.M.—12:00 Noon

Plastics in Packaging
Plastics in Automotive
SPI Vinyl Dispersions Division
SPI Epoxy Resin Formulators Division

12:30 P.M.—Luncheon in Hotel Commodore

Thursday, June 8, 1961

9:30 A.M.—12:00 Noon

Plastics in Appliances
Plastics for Defense
SPI Cellular Plastics Division

Special Events

1. Industry Reception — Tuesday, June 6, 1961

An Industry Reception will be held Tuesday evening, the time and place to be announced.

2. International Reception — Wednesday, June 7, 1961

An International Reception will be held for visitors from abroad on Wednesday evening, 6:00-8:00 P.M., United Nations Headquarters

3. Entertainment

A number of special events—luncheons, receptions, tours—have been planned for visitors and their wives to make the week of June 5-9, 1961, exciting, educational, and entertaining.

SPECIAL FEATURE

National Plastics Exposition

A summary of technical highlights of equipment and materials which plastics industry companies will be showing next month at the Coliseum in New York, June 5-9, 1961

The 9th National Plastics Exposition, sponsored by The Society of the Plastics Industry, Inc. (SPI) will get underway on Monday June 5, 1961. This major event in the plastics industry will feature daily technical conferences (see program), panel discussions, and exhibits. The conference sessions have been scheduled in the morning so as not to conflict with the Exposition in the afternoon.

The highlights of the exhibits which follow will give the reader some idea of the size and scope of the show in June. It will also make possible a quick preview *now* so that time can be spent more profitably at the Conference and Exposition. For the reader unable to get to the Exposition, these technical highlights will help keep abreast of new developments in the entire plastics industry.

Cabbage from the Rio Grande Valley of Texas is shipped to far distant points in fresh, crisp condition by means of a new, tough all-plastic bag

Blow Mold Roundup and Polyethylene Shipping Bags

High density polyethylene with remarkable impact, tear, and tensile strength will be highlighted by W. R. Grace & Co. Shipping bags made from the special resin are said to cut handling costs, reduce freight costs, and lessen product losses. Added bonanza: The bags have reuse value.

High density polyethylene resins for blow molding applications will also be featured by Grace. Blow molded high density polyethylene industrial containers consumed an estimated 3,000,000 pounds in 1960. It is estimated that 5,000,000 pounds will be consumed in 1961, and 40,000,000 pounds by 1965.

ABS Pipe Extrusion

John Royle and Sons will be demonstrating extruder equipment by extrusion of ABS pipe. Highlights of equipment to be shown include an electrically heated 2½" bore extruder with controls, pipe sizing and cooling tank, printing unit for marking the pipe, caterpillar type haul-off unit, and a travelling cut-off saw. Extrusion dies, including a revolutionary new type of sheeting die will also be on display at this company's booth.

Plastics in Buildings

Station used two types of weatherable exterior surfaces—reinforced acrylic panels made from Du Pont's "Lucite" acrylic sirup with fiberglass reinforcement and sheets of Olin aluminum coated with Du Pont's "Lucite" acrylic lacquer

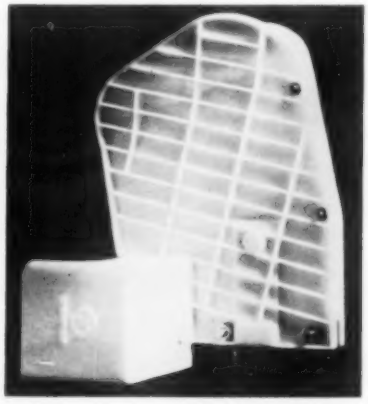
Panels cast from methacrylate monomer for the sign and lighting fields will be exhibited by the Du Pont Co. in June. Also expected to arouse considerable interest will be the flat and corrugated reinforced panels made by Owens-Corning Fiber-Glass Corp. and Russel Reinforced Plastics from Du Pont's acrylic sirup. The reinforced acrylic panels are said to have increased weatherability and color retention over earlier types of reinforced panels. Applications now include skylights, wall partitions, decorative paneling, patio enclosures, windbreaks, fences, etc.

Also to be on display at Du Pont's exhibit will be parts molded from acetal, nylon, acrylic, fluorocarbon, and polyethylene resins.

Opportunities in Polyethylene Processing

Forecasts for market development in 5 basic areas—film extrusion, coating and laminations, injection molding, blow molding, and wire coating and pipe extrusion—will be developed by U.S. Industrial Chemicals Co. at the Exposition. Each area will be manned by technical and market experts ready to answer all processors' questions on production problems and market potential.

Of special interest will be a selection of small boats—rowboat, motorboat, and sailboat—molded from USI's finely-divided polyethylene. The boats, 8 to 10 feet long, will present dramatic evidence of the potential of this product as a raw material for a wide variety of new products.



Its erosion resistance, strength, weatherability and non-tracking or non-carbonizing properties were the key factors in the selection of Du Pont's acetal resin (Delrin) for this arc chute by Westinghouse Electric Company

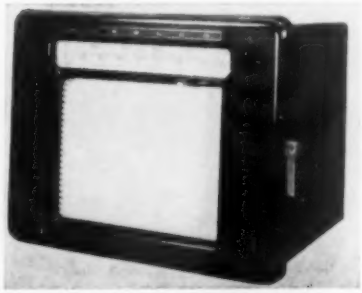
Pressure Indicator and Controllers

Series 400 Pressure Indicator—Pressure and temperature selector switch, 6" scale direct reading, high or low limits

Barber-Colman will be exhibiting instrumentation of the indicating as well as the indicating and recording types for use by the plastics industry. Instruments in both the potentiometric and millivolt types will be highlighted. One of the instruments to be on display is an indicator recorder capable of recording any combination of temperature or pressure up to 24 points. It incorporates separate 11-inch scales and has up to six high or low limit switches.

The millivolt type pressure temperature instrument which will be shown has incorporated on the face of the instrument a selector switch so that direct readings on either temperature or pressure can be directly read.

Also on display will be new circular scale combination indicator recorder instruments which will indicate, control, and give permanent record of such variables as revolutions per minute and feet per minute.



Series 8000 Indicator/Recorder—Any combination of temperature or pressure recording up to 24 points. Separate 11" scales, up to six high or low limit switches, electronic potentiometer, swing out chassis

New Metering Conveyor

Two new pieces of equipment with unique engineering features will be on display at Whitlock Associates' (Inc.) booth. One is a metering conveyor which, it is reported, is already enjoying considerable success in metering color concentrates to the natural material with high accuracy. The equipment is already in use in the automotive industry. Whitlock will have the conveyor in operation at their booth.

Also to be displayed will be car unloading equipment in a range from 1000 to 8000 pounds per hour. The equipment can be coupled in with inter-plant conveyance of the material directly to the machines. Equipment is priced in the range $3000 to $6000.

Plasticizers

Monsanto Chemical Company's Organic Chemicals Division will be featuring plasticizers on the central theme of "Opportunity Route to Better Plastics." Of particular interest will be a flame-retardant organophosphorus compounds. These compounds are compatible with a wide variety of polymeric systems, their color is low to permit use in clear and light-colored plastics and films, and the low acidity and excellent hydrolytic stability of some of them permits use where maintenance of superior electrical properties is desired.

The company will also be exhibiting its Santicizer line of polymeric plasticizers.

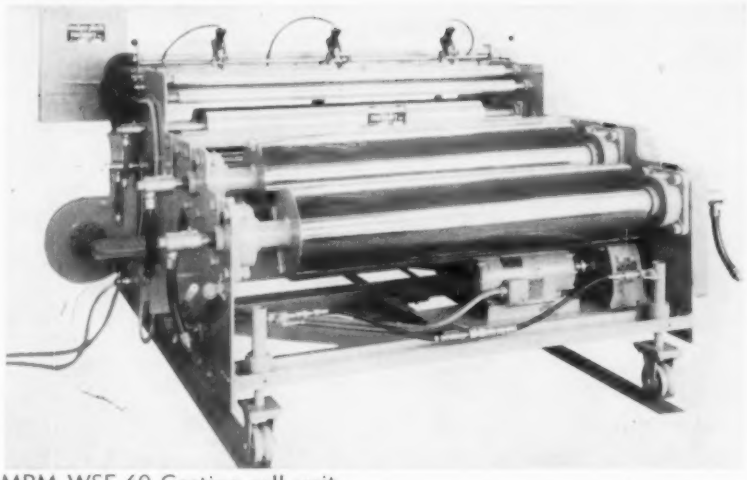
New Extruders, Mixers, and Blow Molders

"Compacts' have hit the plastics industry, too. Prodex will be featuring a new Compact extruder at the June Exposition. According to the company, the new Compact has output rates of 50-150 lbs/hr and L/D ratios of 20:1 and 24:1. The machine occupies only half the floor space required for extruders with similar production capacities. Of special interest to extruders: The machine has a price tag which aggressively competes in the international market. It is shipped completely prewired and fully instrumented.

Mixers of latest design and featuring vacuum-tight construction, with capacities of ¼ to 12 cubic feet will also be on display.

In blow molding machines, Prodex will be showing equipment with toggle-operated mold platens, pneumatically actuated.

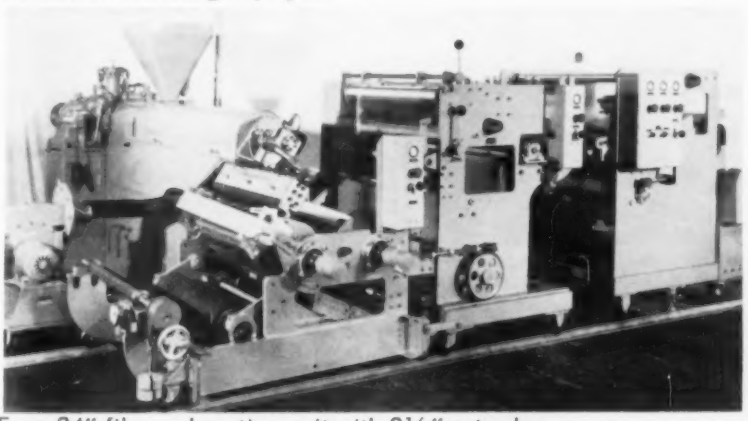
Casting Roll Unit



MPM WSF-60 Casting roll unit

Chill roll casting equipment for production of high quality polyethylene, polypropylene, PVC, and other film will be featured by Modern Plastic Machinery Corp. Edge trimming is done by two rotary knives, each with its own drive motor, or razor blade slitters, and the scrap trim is removed by an integrated blower system. A hot-knife cut-off system is included. Windup consists of a turret-type windup utilizing plug type core holders for 3½" O.D. cores. The maximum roll which can be wound is 20" in diameter. Standard speed range is 20-320 fpm. According to the company, the unit's "coat hanger" type die assures a uniform distribution of pressure and flow, helping to maintain accurate gauge control.

Extrusion Casting Equipment



Egan 24" film and coating unit with 2½" extruder

A complete 2½" extruder with sheeting die, chill roll unit, take-up and winder will demonstrate the extrusion casting of polyethylene and polypropylene film, according to Frank W. Egan & Co. of Somerville, N. J. Also to be on display (actual units or photographs): Extruders ranging in size from ¾" to 10" in diameter and equipped with either direct air cooling or Willert Temperature Control Systems; extrusion of plastic pipe, tubular polyethylene film and quench hi-density polyethylene film; extrusion coating, foamed plastics, blow molding equipment, solution and aqueous coating machines; dryers, printers and miscellaneous equipment.

Blow Molding Polyethylene

Eastman Chemical Products, Inc. will be featuring technical developments in blow molding of polyethylene. A blow molding machine will be in operation.

Other Eastman resins to be featured: acetate, butyrate, propionate, polypropylene, polyethylene, and polyester.

Polypropylene for Elevated Temperatures

Enjay Chemical Co. will be exhibiting a new polypropylene grade tailored to give superior performance for extended periods at high temperatures. The company will be suggesting those applications in which molded parts are subjected to repetitive, long-term heat exposure, such as backs for TV sets, radio cabinets, cable connectors, clothes dryers and dishwashers. Price of Enjay's new grade is $0.46¢/lb. in 20,000 lb. lots, natural color. The material can also be supplied in a variety of colors.

The company will also feature an injection molding demonstration.

Raw Materials

Expanded or new facilities for making raw materials for the chemical and plastics industries will be featured by Pittsburgh Chemical Co. These include facilities for making phthalic anhydride, maleic anhydride, fumaric acid, sulfuric acid, oxo alcohols, and plasticizers.

Urethane Foams

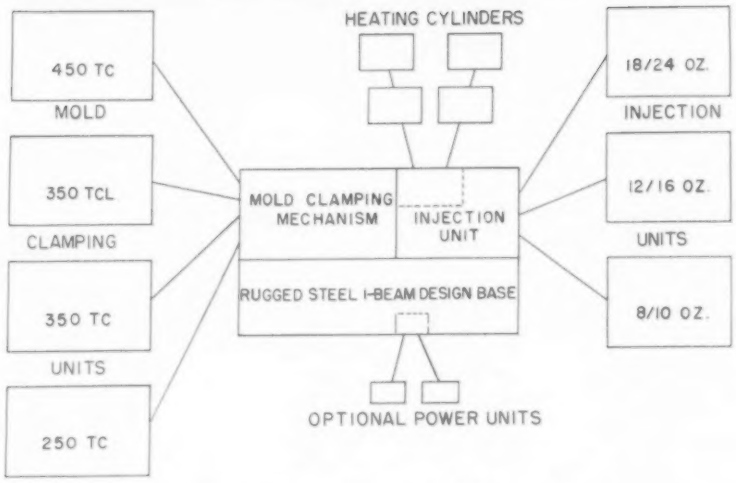
With cushioning of Nopco Lockfoam, the aircraft seats provide controlled resilience and uniform support, may be cleaned, sterilized and re-upholstered many times

Pour-in-place urethane foams will be exhibited by Nopco Chemical Company. Also, a number of products will be on display showing the use of urethane foam in insulation, structural, potting, cushioning, packaging and buoyancy.

The company plans to introduce a new foam for low temperature insulation at the Exposition. The foam, according to Nopco, insures dimensional stability at −10°F or below, a k factor of 0.12 and superior distribution of the foam in the mold.

A new special formulation polyester urethane foam for garment interlinings will also be featured at the company's booth.

Injection Molding Machines



Reed-Prentice modular design injection molding machines

Reed-Prentice Division, Package Machinery Co. will introduce a complete new line of injection molding machines at the Plastics Exposition. The machines feature modular design and have interchangeable mold clamping mechanisms and injection units that make possible 12 different combinations. According to the company, this enables the molder to choose the exact combination of locking tonnage and injection capacity best suited for a particular molding requirement.

The manufacturer reports that a patented monitor-type safety circuit assures the utmost injection machine operating safety. The machine's front safety door is equipped with double limit switches and a hydraulic lock. The switches are interlocked with a hydraulic arrangement that is self-monitoring. If any part of the circuit fails, the machine will open and stop. Also, once the safety gate has been closed, the operator is kept out of the press until it is safe.

Rotating Spreader to be Featured

Fellows Gear Shaper Co. will be demonstrating a 3 oz. injection molding machine with a rotating spreader. The modification is reported to give a more uniform melt temperature, lower molding pressures, faster cycles, and improved dry color blending.

Polypropylene

Both extruded and molded polypropylene will be featured by Firestone Plastics. The company has facilities for manufacturing polypropylene at Orange, Tex. PVC resins will also be prominently featured with applications in sheet, floor tile, and latex.

Marking Machines

Two new marking machines—one for color high speed ink press for cylindrical objects and the other an air-operated hot stamper for flat items, will be demonstrated by the Apex Machine Co., College Point, N. Y.

Unit Construction Extruders

Machinery to be exhibited by Heinrich Equipment Corp. (Reifenhauser U.S. Sales Corp.) will include a 4½" extra-long 25:1 L/D extruder with floating feedscrew and a 100 HP in-line drive with high torque and high speed gear reducer. A smaller laboratory-size extruder also will be shown. Both extruders are of the latest "unit construction", according to the company.

The company will be offering technical advice in these three specialized areas: Extrusion of biaxially oriented polyolefin pipe, extrusion of flat and corrugated rigid PVC sheet, and extrusion of containers and drinking cups.

Color Concentrates

Marbleized color concentrates for wall tile, trophy bases, various grain effects, display boxes, etc. will be featured by Plastic Molders Supply Co., Inc. The color concentrates—called Mottl·Mix are fed into the blender like dry colorant.

Reinforcements and Additives

Ferro Corporation's display at the Exposition will feature that company's three divisions' products. The Fiber Glass Division will have glass mat and roving reinforcing materials, of interest to the compression molder. The Chemical Division will have its line of stabilizers of interest especially for non-toxic formulations and vinyl foams. The Color Division will be featuring new color effects in polystyrene, polyethylene, acrylics, and polyesters.

Mold Temperature Control

Heating and temperature control equipment

Among the various units of mold temperature control equipment to be exhibited will be several units by Sterling, Inc. designed to circulate heat transfer fluids at much higher temperatures (up to 550°F) than is possible with water circulating units. Big engineering advantage, according to Sterlco is the relatively low pressure needed to circulate the heat transfer fluids.

Screw Injection Molding

Visitors at Farrel-Birmingham's booth will have an opportunity to see that company's new 12-20 plunger and screw-type injection molding machines in operation.

Rigid Vinyl Sheeting

William A. Olsen, vice president-promotional sales for Nixon-Baldwin Chemicals, Inc., Nixon, N. J. holds a prototype roll of the company's new extruded rigid vinyl sheet to demonstrate its exceptional clarity and rigidity

Nixon-Baldwin Chemicals, Inc. successor company to Nixon Nitration Works will show its new regular and high impact rigid vinyl sheeting that is crystal clear due to an especially designed process. The booth will contain samples of most all the company's thermoplastics, such as extruded cellulose acetate, cellulose nitrate, cellulose acetate butyrate, polystyrene, ABS and calendered vinyl sheeting.

The new vinyl sheet, according to the manufacturer, has absolute clarity, excellent formability, is chemically resistant and dimensionally stable, contains no plasticizer, doesn't support combustion and cannot warp since it absorbs no moisture.

Chemicals for the Plastics Industry

Wallace & Tiernan Inc. will participate in the Plastics Exposition with a display covering chemicals for the plastics industry produced by both the Harchem and Lucidol Divisions of this company. The Harchem Division display will present their polymerics, sebacates, adipates, phthalates, sterates, oleates, as well as stearic acid.

The featured products of the Harchem Division are Harflex 330, the polymeric vinyl plasticizer with the lowest level of odor and taste and Harchem odorless Dibutyl Sebacate for use in FDA approved food films.

The Lucidol Division will devote its promotion to Diacyl Peroxides, Aldehyde Peroxides, Hydroperoxides, Dialkyl Peroxides, Ketone Peroxides, Peroxyesters, and Di-functional Peroxides.

Emphasis will also be on a new group of diperoxide derivatives which can be used in chemically cross-linking polyethylene.

New Urethane Elastomer

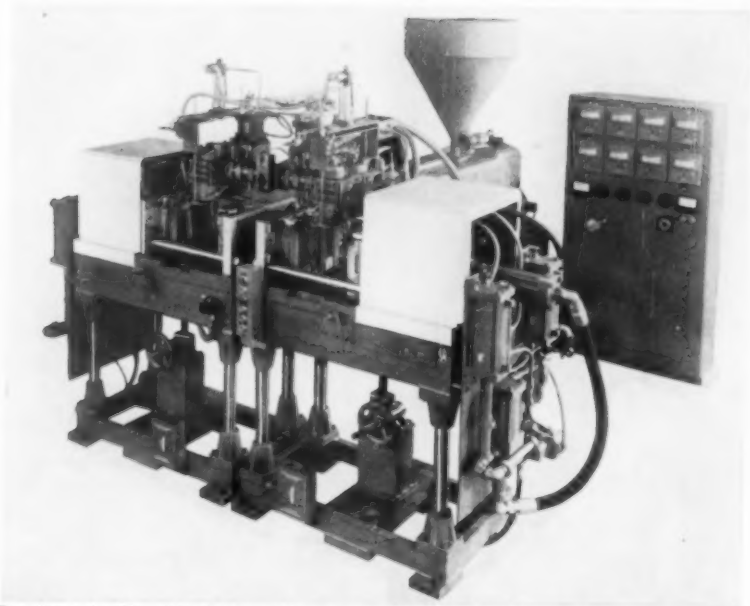
Commercial and experimental applications for Texin, Mobay's new urethane elastomer product for molding and extrusion, will be on display, with special emphasis on heavy-duty parts and components for the original and industrial equipment industries. Extensive technical information and demonstrations of properties will be offered to help interpret prime areas of practical application for these highly-functional engineering materials.

Mobay Products Company, subsidiary of Mobay Chemical, will exhibit a collection of new industrial applications for Merlon, its high-impact, heat-resistant thermoplastic introduced about a year ago. High dimensional stability, good mechanical properties, transparency and self-extinguishing feature have helped place this thermoplastic high on the list of new plastic materials to investigate in the electronics, industrial component and lighting fixture fields, according to Mobay.

High Density Polyethylene

Burst and flexural tests will be used by Goodrich-Gulf Chemicals to highlight its high density polyethylene. The company will be showing the technical advantages of using high density polyethylene for such applications as extrusion of pipe and insulation for wire and cable, and blow molded products.

Blow Molding Machines



Producto's flexible Versa-Blow series includes the double press Mod. VD-2

New blow molding machines will be demonstrated by the Plastics Machinery Division of The Producto Machine Co. Outstanding engineering advantages of the line, according to the company are as follows: Each molding press has 3-way micro-positioning adjustments for centering mold under parison; each press also has positive, high-speed equalized opening and closing, insuring dead center mold alignment; high-speed horizontal inline, accumulator for perfect parisons; self-cleaning; three separate head adjustments regulate parison weight, concentricity and straightness; advanced head design assures trap-free flow of parison.

Diallyl Phthalate Resin

The diallyl phthalate resin varnish applied to this carbon resistor produces a hard, chemical-resistant coating after curing at 320°F. for 15 minutes

Dapon diallyl phthalate resin, Oxiron epoxy resins, and plasticizers will be on display by the Chemicals and Plastics Division of Food Machinery and Chemical Corp. Recent developments that are expected to be of special interest at the Exposition: Varnishes based on Dapon diallyl phthalate resin which makes it possible to utilize its insulating and electrical properties for the first time in dip encapsulation, coating, sealing, and laminating applications; Oxiron epoxy resins which have just become available at a commercial price level.

Vinylidene Fluoride Resin

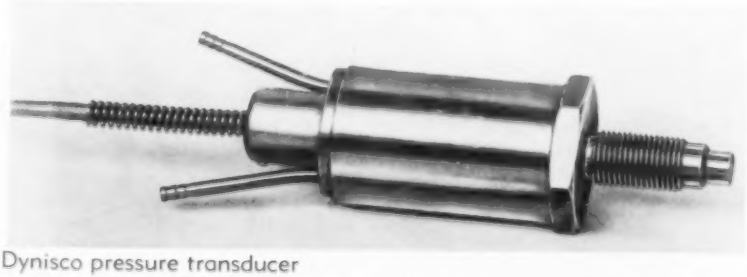
Pennsalt Chemicals Corporation will display for the first time, articles fabricated from their new vinylidene fluoride resin (KYNAR) at the Plastics Exposition. The exhibit will emphasize the resin's resistance to extreme environments, mechanical strength, and formability. It is a fluorine-containing thermoplastic which Pennsalt claims is useful in continuous service to 300°F. It is resistant to most corrosive chemicals, petroleum fractions and organic solvents. It is particularly resistant to weathering, ultraviolet radiation and will retain useful structural strength even after exposure to 300 mega Roentgens of nuclear radiation. A tensile strength of 6800 psi, flexural modulus of $2x10^5$ psi, unnotched Izod impact of 30 ft-#/in typify its mechanical properties. Other properties of interest include: negligible water absorption, dimensional stability, low creep or cold flow, and a high heat distortion temperature. Fabrication is accomplished with relative ease and with latitude in the choice of tooling and conditions. Vinylidene fluoride articles fabricafed by extrusion, injection molding, transfer molding, blow molding, compression molding and vacuum forming will be on display.

Moldmaking Technology

Detroit Mold Engineering (DME) will display standard mold base assemblies for injection and compression molding. Also featured will be DME's complete line of standard ejector pins, core pins, ejector sleeves as well as moldmaker's tools and polishing supplies.

The company also plans to show how its pioneering in standardization benefits mold designers, moldmakers, and molders.

Pressure Transducer



Dynisco pressure transducer

A new injection molding pressure transducer measures small and rapid pressure fluctuations in the plastic melt during the molding cycle. The transducer, manufactured by Dynisco, Inc., will be displayed at the Exposition next month. Water or air cooling may be employed to maintain the unit at a safe operating temperature, even though the diaphragm may be exposed to a plastic melt have a temperature of 750°F. Units with pressure ranges up to 20,000 psi are now available, and units satisfactory for use at 30,000 psi will be available in the near future.

ABS Resins

All-plastic interior for the "car of tomorrow" is shown in a cutaway model developed by Marbon Chemical Division of Borg-Warner Corporation. Interior components are made of ABS polymers

Principal feature of Marbon Chemical's exhibit will be a full-scale cutaway of an automobile, demonstrating the advantages of this company's ABS resins for all interior components in the car of tomorrow. Eight different applications show the material's unusual combination of dimensional stability and toughness: Steering wheel, instrument cluster, transmission console, ceiling headliner, seat shells, inside door liner, tail light reflector unit, and trunk liner section.

Quality Control Equipment

A system using radioisotopes to continuously and automatically measure and control production of plastic film and sheet will be displayed by Industrial Nucleonics Corp. According to the company, thickness can be measured down to a millionth of an inch. Elements of the equipment to be displayed: The measuring unit, a structure housing the radiation source as well as the ionization chamber which converts the amount of radiation received into a signal proportional to the weight of the material intercepting the detector and the source unit; the second element is an operator's control station consisting of a recorder and electronic control equipment needed by the machine operator.

Also included in the display will be two electronic cabinets containing automatic feedback equipment.

Heating Cylinders

One of the special features of the Injection Molders Supply Co. Inc. exhibit will be the showing of a transparent model of a Vented Reverse Flow (VRF) Heating Cylinder. The workings will be fully explained to those interested.

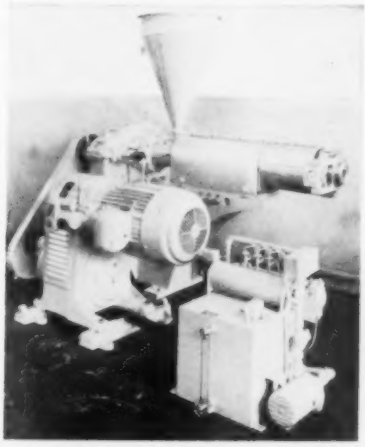
Vinyl Information Center

Carey Chemicals will have a vinyl information center showing a wide variety of products that can be made with vinyl. An interesting point will be that the major portion of their booth will be made out of vinyl in various forms. They will show new products including an all vinyl plastic non-metallic jacket for wire and cable for building and the construction industry. They will also show the use of vinyl for shoe manufacturing and will present their expansion plans with Tennessee Gas Transmission Company.

Polystyrene and Nylon

Foster Grant will be telling a completely customer-oriented story at the Exposition. The company feels that as both a producer of raw plastic materials and as a major molder, it has more to offer the molding industry than any other producer. Featured will be Fostarene, a general-purpose polystyrene, Fosta Tuf-Flex, a high-impact polystyrene, and Fosta-Nylon.

Induction Heated Extruder



2½" induction heated extruder

The Black-Clawson Company, Hale and Kullgren Plastics Department will display the new Model 150, 2-½" Induction Heated Extruder, along with the Aetna-Monsanto Quick Change Screen Pack Unit for use on extruders.

The Model 150 line is shown on the attached Photograph F-8215-1. General information is shown on Page 4 of the attached Brochure HK-10, and specifications are listed on Page 11 of the same brochure.

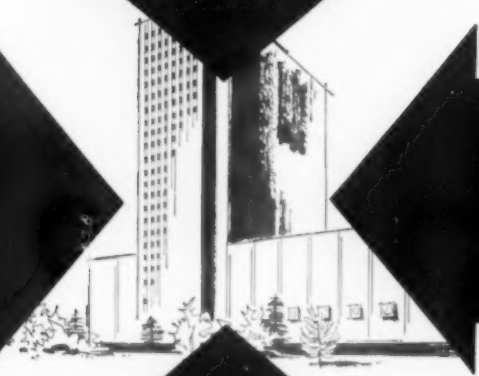
The quick change screen pack device was developed by The Monsanto Chemical Company and is manufactured and sold exclusively by The Black-Clawson Company, Hale and Kullgren Plastics Department, under a license agreement.

In addition to the above, the company plans to display a cross sectional assembly (model) of the Mark "V" Induction Heated Die used throughout the plastics field in the manufacture of extrusion coating, laminating, and flat film.

Thermoplastics on Display

B. F. Goodrich Chemical Co. plans to have on exhibit products fabricated from thermoplastic polyurethanes, ABS materials, and high-temperature vinyls. Also shown will be items made from conventional vinyl resins, compounds and latices by newly-developed applications. The company will be showing products which have been made by both new and established production methods, including molded goods, coated, sprayed and saturated materials, pipe and other extruded items, cellular and calendered products.

COME SEE WHAT'S NEW IN PLASTICS



Coliseum, New York City

Come profit with plastics in the $4 billion marketplace • See the National Plastics Exposition—this huge show is the major event in the plastics industry • Sponsored by The Society of the Plastics Industry, Inc. • 250 Park Avenue, New York 17, N.Y. • Advance registration forms now available • Please make requests on company letterhead.

9TH NATIONAL PLASTICS EXPOSITION NEW YORK COLISEUM JUNE 5-9 1961

Among the important factors in Shell Chemical's decision to make polystyrene were its extensive background in polymers and its raw material position. Two other Shell thermoplastics followed quickly—polypropylene and polyethylene.

BULLETIN:

On May 3, 1960, a remarkable thermoplastics decision was made by Shell Chemical

Read about this Shell decision. And how you can start benefiting today from a major new source of polystyrene, polypropylene and polyethylene that resulted from it.

On MAY 3, 1960, Shell Chemical, a company long basic in styrene monomer and SBR rubber, decided to combine the two in full commercial production of Shell high impact polystyrene. Why was this remarkable?

A revealing fact on polystyrene

The condition of the polystyrene market was not attractive. There was oversupply from some of America's finest companies. The field was mature and Shell was starting late.

One revealing fact offset this situation. *Shell, with its excellent background in polymer chemistry—as exemplified by Shell Isoprene Rubber, the industry's first commercially produced synthetic/natural rubber—could make positive contributions to the thermoplastics field in the form of new products.* But Shell would be severely handicapped without a thorough understanding of how the thermoplastics market works and what it wants.

Result? Shell's decision to go full speed ahead with high quality general purpose, medium and high impact Shell polystyrenes, plus a rapidly expanding technical sales force.

80 million pounds of polypropylene

Two other thermoplastic developments followed quickly.

One, Shell's announcement in October, 1960, for an 80 million pounds a year polypropylene plant with customer service and research facilities to be built near Woodbury, N. J. Two, an arrangement by which Shell will resell limited quantities of polypropylene until this plant comes on stream.

Custom-made polyethylene

And this, in turn, led to a third important thermoplastic.

In order to round out a complete line of thermoplastics, Shell Chemical, in January, 1961, made arrangements to supply the industry with the highest quality custom-made polyethylenes.

How to start benefiting

Thus, within 8 months, Shell became an important factor in three plastics: Shell polystyrene, Shell polypropylene and Shell polyethylene.

The next 8 months should be even more important. Shell will be going full speed ahead searching for new polymers you want.

Now is the time to let Shell's technical representative know your needs. Tell him about them on his next visit or write Shell Chemical directly at:

42-76 Main St., Flushing 55, N.Y. FLushing 3-4200; 20575 Center Ridge Rd., Cleveland 16, O. EDison 3-1400; 6054 West Touhy Ave., Chicago 48, Ill. SPring 4-6711; or 10642 Downey Ave., Downey, Calif. SPruce 3-0601.

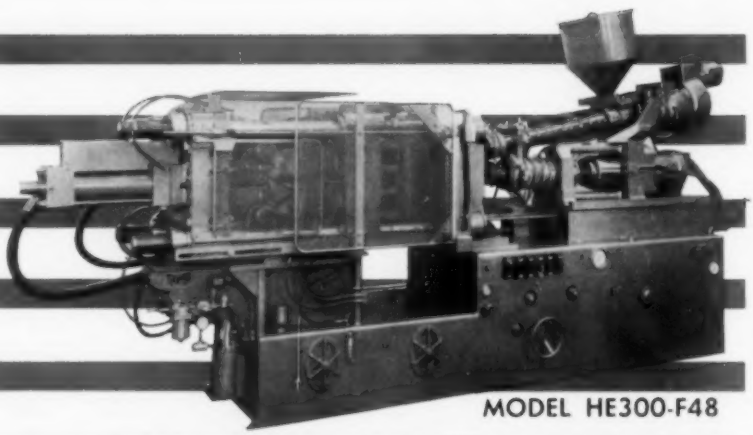
A Bulletin from

Shell Chemical Company

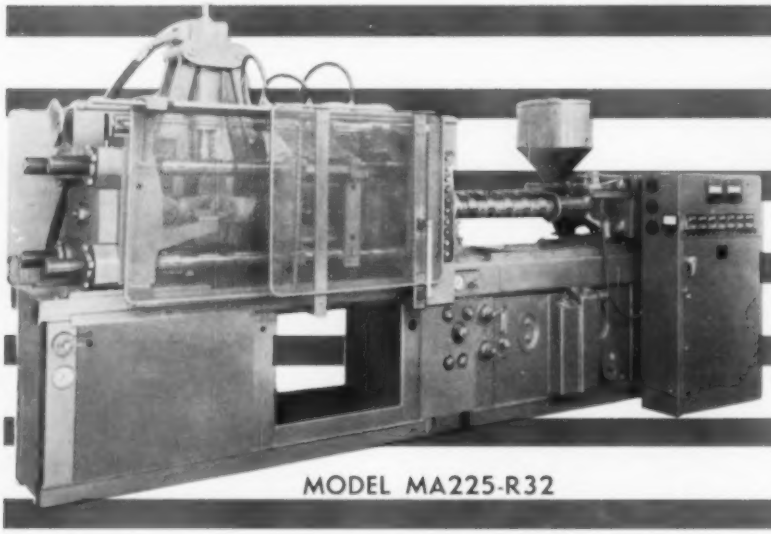
SHELL

Plastics and Resins Division

SEE THE NEW IMPCOs



MODEL HE300-F48



MODEL MA225-R32

AT THE 9th NATIONAL PLASTICS EXPOSITION in NEW YORK June 5-9

To meet the needs of the plastic molding industry, Impco offers a complete line of screw plastifiers. Various design adaptions for this type of plastifying are now available on nearly all of our machine models. Two of these adaptions will be on display at the Plastics Show in June. See them operating at the Coliseum, June 5-9, or send for additional information. We will be happy to discuss these and other significant improvements to the accepted leading make of injection molding machines.

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IMPROVED MACHINERY INC.

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IN EUROPE: SUNDS VERKSTADER AB, SUNDSBRUK, SWEDEN

The History of Blow Molding

Through The Ages . . .
the continuing story of Blow Molding,
from blowing amber shapes
to polyethylene bottles

Gerard C. Heldrich

W. R. Grace & Company
Polymer Chemicals Division

With commercial blow molding currently the most rapidly expanding segment of our trade arts, we begin to think of it as something new. The art of blow molding thermoplastic materials actually goes back to the primeval days. The glass artisans of ancient Egypt and Babylon, working with the great natural thermoplastic of their time, natural Amber, found that the same equipment that blew glass would also blow Amber.

Amber was melted in ceramic pots over wood fires to a consistency wherein it could be blown on a blow pipe. Excellent exhibits of blown Amber are available in the museums of New York and Philadelphia. The application of blown parts in these ancient days was primarily for figurines and other decorative articles for milady's bedroom. In the same period artists developed a technique for forming ivory and other types of tusks and bone by blowing. As white men penetrated into deepest Africa and North and South America, they found many useful articles blown from animal tusks. The tusks were first dried so that the marrow in the center could be cleanly removed, leaving a hollow article or parison ready to be blown. Then they were soaked in boiling water, sometimes for several days. The natural oils and resins that bound the calcium of the tusks together softened sufficiently so that they could be placed in molds made from clay and blown. After stretching or blowing, they were placed in the sun to dry out and harden. Finally, the articles were frequently engraved and often embellished with gold and silver.

The art of blowing natural resins continues largely to this day. While Amber is still a semi-precious natural resin, many synthetic materials have now replaced it. Ivory and animal tusks are still blown to useful and

attractive shapes and decorated with precious metals and gems for those who can afford their exclusive handwork and delicate appearance.

Celluloid is Developed

With the development of celluloid in the 1880's and the ability to produce it in sheet form, before long the inventors of the day found that by heating two pieces to flow point, clamping them in a compression type mold and injecting air into the mold between the two sheets, it was both possible to form the sheet into a hollow article, and to pressure seal the softened pyroxalin. This art gave birth to the development primarily of useful articles for the home and the hollow-ware toy industry.

Some of the first items made were blown baby rattles. The art of making celluloid baby rattles in this fashion continued without competition until the outbreak of World War II. Other plastic materials and techniques rapidly caused a diminishing in the use of celluloid both due to the flaming hazard of cellulose nitrate, and the development of newer, cheaper materials.

During the "hey day" of blow molding celluloid, about 1910 to 1925, such items as hair brush backs, toilet seats, pingpong balls, baby rattles, doll heads and doll bodies, mannequins and mannequin legs and hands, lamp bases, cutlery handles and jewelry were blown in the manner described. The rigidity required for brush backs and toilet seats was accomplished by injecting plaster of Paris into the hollow article lending firmness and body and permitting thin walled hollow articles to be used.

Cellulose Acetate Introduced

With the introduction of the cellulose acetate sheet in the 20's and a preference for the flame resistant properties of cellulose acetate over celluloid, the art was extended into the use of cellulose acetate sheet. With the advent of cellulose acetate sheet, blown containers appeared commercially used largely for packaging notions. Many will remember the transparent packages that mother used to have that contained darning thread. This, in effect, was the beginning of commercial applications for blown plastic containers.

Many names of pioneer companies in this art are household words. The Viscoloid Co. which later became du Pont in the plastics business; The Celluloid Corp. now known as Celanese; Fiberloid now Monsanto; Nixon now the Nixon-Baldwin Co.; Prophylactic Brush today the Prolon Division of Warner Lambert, and the Insel Co. now Joseph Davis. Those whose names have not been changed by merger are Foster-Grant, Commonwealth and Great American. All of these companies are important factors in the manufacture of blown hollow articles—some of them for as long as 60 years.

Other notable names in the business are mold makers such as Standard Tool & Die, Leominster, Massachusetts and Newark Tool & Die, Newark, New Jersey, both of whom made molds for celluloid.

The Blow Molding Business

With the development of thermally stable materials, starting with acetate in the late 20's, it seemed only logical that blow molding from molten gobs, such as that done by the ancients, was now ready to appear on the industrial scene in the form of machinery. The beginning of the 1960 "gold rush" into the blow molding business started in 1935 when Enoch T. Ferngren discovered that, by extruding a molten tube into a closed mold and injecting a fluid such as air, he could form a seamless hollow article. Associated with Ferngren was a mechanical engineer, William Kopitke, who took the elementary principle of Mr. Ferngren and converted it to a mechanical device. This first prototype unit for blow molding, built by Ferngren and Kopitke, together with his patent position were sold to the Hartford Empire Co. in 1937. The foresightedness of this corporation was evident when, around this invention, was created one of the greatest engineering development programs ever undertaken by the industry up to that time. Plax Corp. was set up as a research and development corporation to improve upon the Ferngren-Kopitke machine and to develop new or novel techniques for the blow molding of plastic containers. This development was directed and inspired by James Bailey who, for his contribution to the industry, later received a coveted Hyatt award. By 1940, Plax had a commercial machine that could blow hollow articles but none of the synthetic plastic material available was suitable for containers.

Polyethylene For Containers

During the war years polyethylene was introduced in this country. It did not take Bailey and Kopitke long to blow this suitable material into useful containers. With the closing days of the war, the first commercial polyethylene containers were blown and sold. The Ferngren-Kopitke art has primarily been one of extruding a molten parison through a closed mold and blowing it.

Subsequently, other pioneers in this art who invented machinery, now in popular use, include Elmer Mills, Orville B. Sherman, W. K. Archer and C. C. Coates. They set the pattern for the astounding growth of forming hollow articles from plastic materials for packaging, toys, housewares and industrial uses.

No process, no plant, no research organization or sales department can create a business unless a useful service exists to society. When society demands the use of a product, it becomes important to produce it.

Thus through the blending of the past with the present and the present with the future an old art has not in fact been reborn, but simply has entered upon a great cycle of expansion.

—— ■ ——

Blow molded polyethylene bottles (photo courtesy Celanese Plastics Co.)

READY

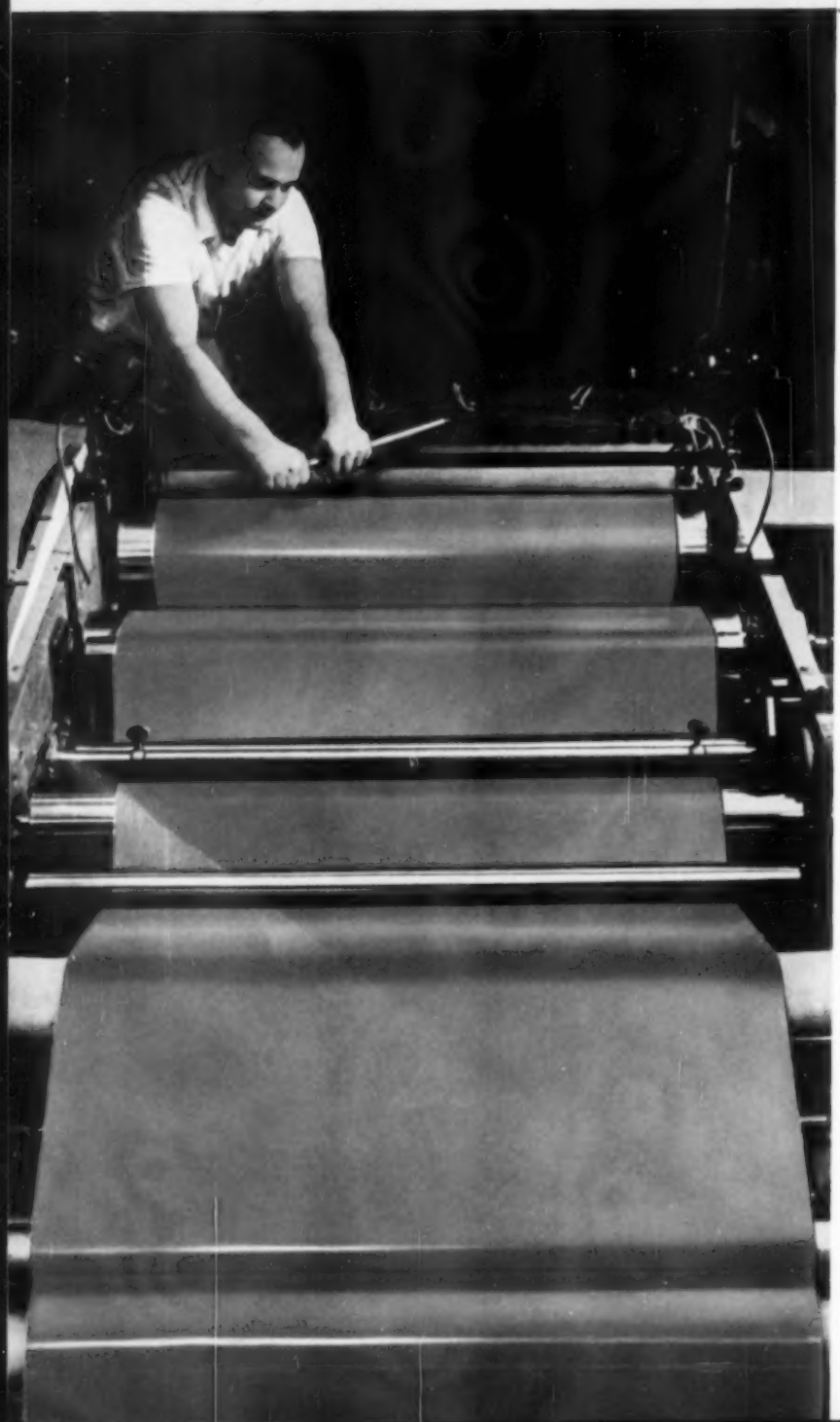
...to help you plan new products
...to help you improve existing products
...to help you cut manufacturing costs

Since February, 1961, Tenite Polypropylene has been in commercial production at Eastman's new plant in Longview, Texas. This is the newest member of the Eastman family of thermoplastics, all bearing the trade name "Tenite."

In Tenite Polypropylene, industry has a versatile new plastic that will replace conventional materials in many traditional applications . . . a plastic that will improve the performance of hundreds of existing products . . . a plastic that could markedly reduce material, fabricating and assembly costs.

And it's a material that's now available in carload quantities.

Tenite Polypropylene offers a broad range of useful properties



High Strength – Tenite Polypropylene has good tensile and impact strength, plus rigidity and surface hardness.

Light Weight – Tenite Polypropylene is the lightest of all solid plastics. This plastic produces more molded or extruded product per pound than most other plastics.

Heat Resistance – The high melting point of Tenite Polypropylene permits objects made from this plastic to be sterilized without suffering distortion. This feature makes it well-suited for hospital and laboratory ware.

Chemical Resistance – Tenite Polypropylene resists the attack of acids and alkalies and a broad range of other chemicals.

Fatigue Resistance – Because it can take innumerable flexings, Tenite Polypropylene can be designed as one-piece moldings with integral hinges.

Resistance to Moisture Vapor Transmission – Tenite Polypropylene is an effective barrier to moisture vapor transmission. In film for packaging, this feature is a vital factor in prolonging the freshness of many foods.

Red polypropylene sheet rolls off an extruding machine in Eastman's plastics development laboratory. For two full years before launching polypropylene production on a full-scale commercial basis, Eastman engaged in exhaustive research and study of the characteristics and properties of polypropylene, thoroughly pretesting the material in actual molding and extrusion operations and developing a number of formulations for use in plastics fabrication.

Tenite Polypropylene can be used in all these ways

Dielectric Strength – Tenite Polypropylene has excellent dielectric properties and retains these properties even under adverse moisture and temperature conditions.

Abrasion Resistance – Tenite Polypropylene has excellent abrasion resistance. Its surface hardness suggests its use as gears or bearings. Conveniently, it also has a low coefficient of friction.

Resistance to Environmental Stress Cracking – Tenite Polypropylene has excellent resistance to stress cracking. No environment has yet been discovered in which stress cracking of polypropylene occurs.

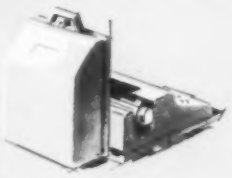
High Gloss – Articles molded of Tenite Polypropylene have a natural lustrous finish, and film extruded of Tenite Polypropylene exhibits a sparkling surface.

Heat Sealability – Tenite Polypropylene is relatively easy to "tack" or "weld." This can be accomplished in many cases with existing equipment.

Printability – With a simple treatment, film of Tenite Polypropylene can be easily printed by conventional methods.

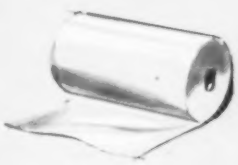
Resistance to Mold and Mildew – Tenite Polypropylene resists the growth of mold or mildew, and is not attacked by insects or marine organisms.

Processability – Tenite Polypropylene has excellent flow properties, permitting good mold-fill in injection molding.



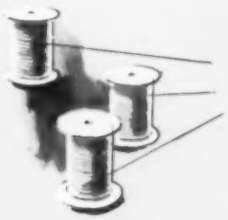
Injection Molding

Tenite Polypropylene can easily be molded into a wide variety of durable low-cost parts with high gloss and surface hardness—for example, appliance housings, automotive accessories, toys and housewares.



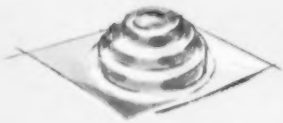
Extruded Film and Sheeting

Tenite Polypropylene can be extruded into sparkling clear film and sheeting, with the excellent protective characteristics so important for durable packaging. It can also be extruded in opaque, translucent, or transparent colors.



Monofilament

Tenite Polypropylene can be extruded into monofilament offering high strength, wet or dry, and excellent flexibility at low temperatures. Webbing for outdoor furniture and cordage are among the many possible end uses for this tough material.



Thermoforming

Sheet of Tenite Polypropylene can be used in vacuum forming, pressure forming and skin packaging, with existing equipment.

Wire and Cable Covering

Excellent electrical, thermal, and mechanical characteristics make Tenite Polypropylene desirable for either primary insulation or jacketing. Formulas are available for solid coatings, or for cellular coatings of extra-low dielectric constant.

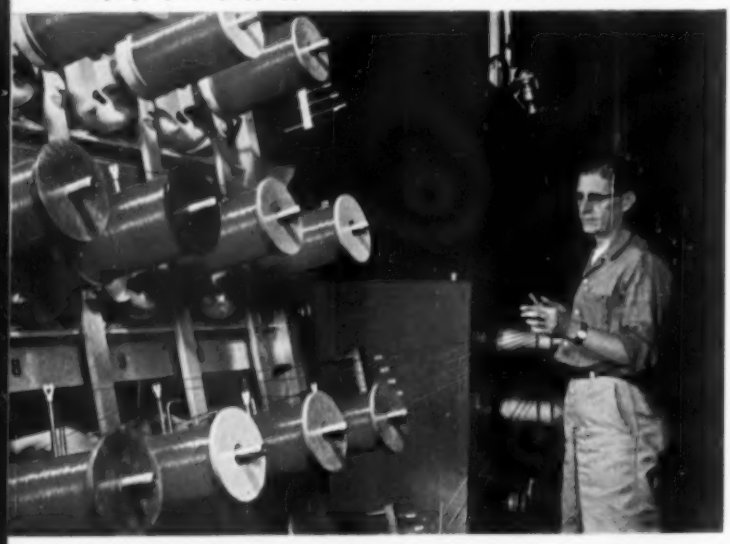
Pipe

Chemical inertness, resistance to stress cracking, and heat resistance make pipe of Tenite Polypropylene a good choice for industrial use.

Blow Molding

Tenite Polypropylene in special formulations can be blow-molded into many articles possessing exceptional wall strength, resilience, and chemical resistance.

Spools of lustrous red polypropylene filament, extruded for testing purposes in Eastman's development laboratories. Eastman's work over many years in producing plastics of almost unlimited colors has been of significant value in developing superior polypropylene formulations for monofilament extrusion.



A special word about this new polypropylene

The process for manufacturing Tenite Polypropylene was developed by Eastman scientists, engineers and production staff. This exclusive process yields a polypropylene that is superior in several characteristics to other polypropylenes. We base this statement not only on our own laboratory findings but on the opinions expressed by those users who have had the opportunity to evaluate Tenite Polypropylene from our semicommercial plant during the past year.

Since the first Tenite plastic was produced, in 1932, over 42,000 color effects have been formulated in the Tenite color laboratory. This experience, plus pre-eminence in color photography and textile dye technology, enables Eastman to offer the broadest range of colors available in the entire plastics industry. We believe that Tenite Polypropylene represents an improvement in quality and stability of color in this type of plastic. And Tenite Polypropylene color concentrates now offer molders and extruders a clean, easy way to color polypropylene. Use of these concentrates virtually eliminates color contamination and color uncertainty.

We have given you only the highlights on this promising new plastic. For further information, call a Tenite sales office or send this coupon to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

This glimpse into the color chip storage room at the Tenite Color Laboratory gives some indication of the variety of colors that has been developed by Eastman since 1932.

Measuring the optical properties of Tenite plastics is but one phase of the diverse and thorough testing done in the Tenite Quality Control Laboratory.

Eastman technical service representatives are ready to work with any customer in finding the most efficient way in which to fabricate products of Tenite Polypropylene.

EASTMAN CHEMICAL PRODUCTS, INC.
subsidiary of Eastman Kodak Company, Kingsport, Tennessee

Please send me more information on Tenite Polypropylene,

for _____
(product or purpose)

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All this explains why time-tested 9720 is the largest selling polymeric today. Why not let this talented low-cost performer take you out of the "cut cost—keep quality" squeeze. For complete details write Dept. J-5 for booklet—"Plastolein Plasticizers."

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SPEAKING OF EXTRUSION

An Introduction to Extrusion for Blow Molders

A training guide for new entrants to the blow molding field

In recent years, blow molding has enjoyed a phenomenal growth, spurred by the advent of new resins and availability of custom machinery.

This growth has been shared alike both by the established blow molders and new entrants.

This article deals with both mechanical and practical considerations of the extruder itself. It is intended to be of assistance to new entrants to the blow molding field and should be of some assistance to those already established in training of new personnel.

The Extruder Anatomy

The function of the extruder is to properly plastieize the plastic, to color or homogenize mixtures of plastics, and to deliver it to the die at a proper temperature and at a uniform output rate suitable for blow molding.

Before proceeding further with operating variables, some major mechanical considerations with which one should familiarize himself both in operation and in selection of extrusion equipment should be reviewed. For purposes of discussion, this can be broken down into two major headings;

1. Construction
2. Drive

It is standard practice today to size extruders based on their length to diameter ratio. The diameter referred to is the inside barrel diameter, and the length, the effective length of the screw (generally measured from the front of the feed opening). It is also generally standard to make the pitch equal to the diameter. Thus, an extruder that is 20:1 L/D will have 20 flights ahead of the feed throat and a screw length equal to 20 times the screw diameter.

Gear Reducers

All extruders consist of a gear reducer, a thrust bearing, a means of feeding the extruder, a hardened barrel and screw, a clamp and a heating and cooling system. Each of the several manufacturers has individual designs or combinations of designs of the above components that he has found to produce the best functional operation.

It is not intended to go into details on each of these items, but special consideration should be given the gear reducer and thrust bearing, so that one fully realizes the part that these two major components play. The gear reducer, as its name indicates, takes the high speed from the motor or drive, normally in the range of 1700 to 2300 rpm, and reduces it to standard screw speeds of from 10 to 150 rpm. It must be properly sized to handle the torque and horsepower being used, both from a mechanical and thermal capacity. The reducer is normally rated at some horsepower (*Figure 1*) at a specific rpm. These devices are constant torque and have a straight line relationship between horsepower and rpm, i.e., they can handle higher horsepowers at higher rpm. A belt drive is quite often used between the motor and reducer, thus offering a variable range of reduction at some later date. Care should be taken in changing sheaves to make certain that the proper horsepower and rpm relationships are maintained. Overloading will result in shortened reducer life.

Would you like a reprint of this "primer" on extruders? Just write Editor, SPE Journal, 65 Prospect St., Stamford, Conn., and a copy will be sent your way

Thrust Bearings

An extruder operates normally in the range of 1000-2500 psi at the delivery end. Under very special cases, pressures as high as 10,000 psi are used. This develops a thrust to the back of the machine, a thrust which must be taken up by a bearing. Bearing manufacturers recently agreed upon a method of rating bearings of different designs to some standard comparative basis. Much of the existing literature does not report these new ratings, and there is considerable discrepancy in the ratings. A bearing is rated normally by its B-10 life (*Table 1*). This is the rating in hours, based on statistical analysis that 90% of the bearings will last. 10% may fail at this point or sooner. The average life of the bearing is approximately five times the B-10 life. There is no standard nomenclature known as "B-10 average life". The life of a bearing is dependent on rpm and pressure. The rpm relationship is lineal and if the rpms are doubled life is cut in half. The life is, however, inversely proportional to the cube of the load. Thus, if the load is doubled, the life of the bearing is reduced to ⅛.

Drives

All extruder manufacturers offer an option on extruder drives. Basically, three types are used.

1. The mechanical type with variable-pitch sheaves.
2. The Eddy-current clutch, mak-

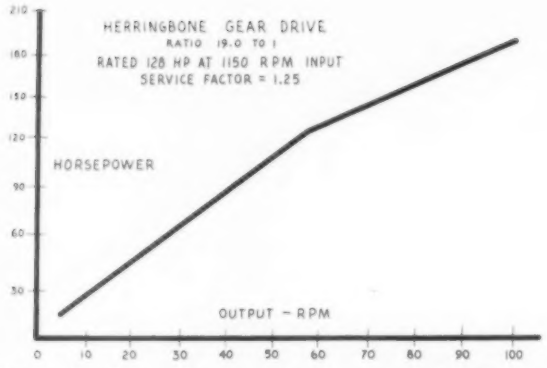

Figure 1. Gear reducers can handle higher horsepowers at higher rpm

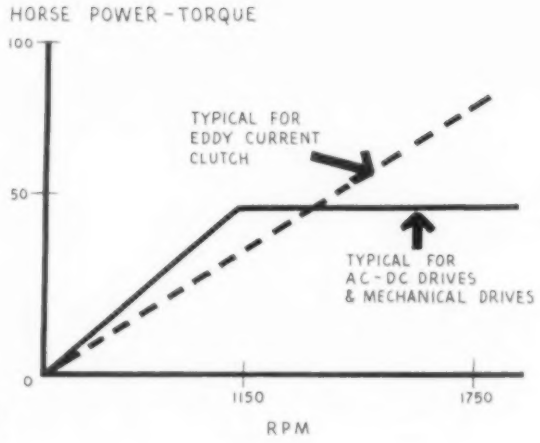

Figure 2. Drives are selected based on the torque/HP requirements of the operation and prices

ing use of a water-cooled magnetic clutch.

3. The strictly electrical type, AC-DC drive of the Ward-Leonard type.

Drives are generally selected based on the torque/HP requirements of the operation and the relative prices (*Figure 2*). The Eddy-current clutch has a linear relationship between torque and HP. The AC-DC type is available both linear and with a portion above a certain rpm at constant HP. The mechanical drive characteristics are quite similar to the AC-DC type.

The Screw

After touching briefly on important mechanical aspects of the extruder, the screw should be examined and the many variables associated with it discussed to efficiently operate an extruder, one should have some appreciation for the variables involved. There is considerable theoretical information available in the literature as well as analytical justification of the theory. Extrusion has, for many years, been considered an art. Today, it closely resembles a science, but much has yet to be learned.

The plastic moves through the extruder because of the relative motion between the screw and barrel wall. If a conventional, helical spring were laid in the flight channel, the path of the plastic material would closely resemble the path of the spring wire. This is to say that as the material moves along the channel axis it is actually following a circular path. The material must stick to the barrel and slip on the screw in order to move forward. If it sticks on the screw, then it merely goes around and does not move forward. The material is sheared or worked as it moves along the screw. This working consumes horsepower that is converted to heat. The screw design, rpm, and back pressure all have a bearing on the rate of throughput, the amount of mixing or quality, and the temperature of the plastic.

Heat in an extruder normally comes from three sources. First, predryers, if involved, contribute to the total heat input as the feed temperature is raised. Secondly, heat comes from the mechanical work, and thirdly, from heat conducted from the barrel wall. Ideally, it is preferable to put the major portion of heat in by friction and then add a small amount of conducted heat to give control of stock temperature. Where excessively shallow screws are involved, or too high screw speeds are used, the stock temperature may override the present temperature of the barrel instruments. Variables which will lower this temperature will also lower output. An extruder is considered to be operating "adiabatically" under such conditions. In blow molding, extrusion temperatures must be kept relatively low to prevent "sagging" of the parison and excessively long cooling cycles. This, of course, places certain limitations on the extrusion operation.

It is desirable to become acquainted with screw nomenclature, commonly referred to in the industry (*Figure 3*). A screw is divided into three major sections:

1. Feed. 2. Transition. 3. Metering.

The feed section picks up the pellets and conveys them forward in the solid state. Generally, several flights of constant depth feed section are provided to level out any irregularities in feed. Because of the reduction in bulk as the material moves forward, a compression is built into the screw. This also serves to prevent the carrying forward of occluded air. The compression occurs in the transition section. The output end generally consists of a section (approximately 25% the length of the screw) of uniform geometry, referred to as the metering section. This area is one of the more critical areas of the screw design, and is the section of the screw most thoroughly understood. It is assumed that the plastic is a melt when it reaches the metering section and consequently follows some of the more basic laws of physics. It should be remembered that most theoretical work pertains to this melt section of the screw only. Important variables in the melt section are shown (*Figure 4*).

The flow in the extruder is generally broken down into three components (*Table 2*). The first is the drag flow, and this is the forward component of flow caused by relative motion between the barrel and the screw. There is a pressure component of flow resulting from the resistance against

Table 1. Some Facts and Figures on Thrust Bearings

	Thrust Bearing
A.	B-10 Life: Statistical Life in Hours that 90% of the Bearings will Perform Satisfactorily
B.	Average Life: 5 Times B-10 Life
C.	RPM Relationship: Is Straight Line
D.	Pressure Relationship: Varies Inversely with the Cube of the Pressure

Example: bearing designed for 8 years at 1000 psi has an estimated life of 1 year at 200 psi

$$\text{COMPRESSION RATIO} = \frac{\text{FEED FLIGHT DEPTH}}{\text{METERING FLIGHT DEPTH}}$$

Figure 3. Nomenclature of the screw

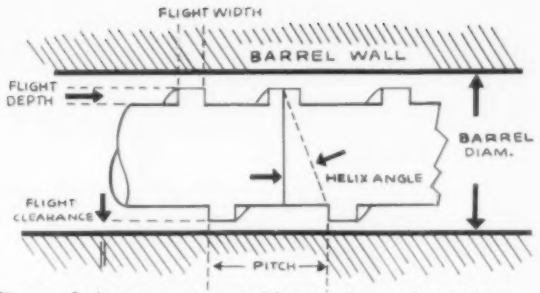

Figure 4. Important variables in the melt section

which the screw is operating. The pressure flow can be either negative or positive, depending upon screw design. The third flow is the leakage flow which is the material that passes over the screw flight in the clearance between the barrel wall and the screw.

It is difficult to visualize the effect of the various variables on operation of the screw when viewed in its conventional physical form. It is relatively easy, however, when considered in light of their effects on pressure and output.

If output and pressure at several different die openings are plotted what is commonly referred to as a screw characteristic line is produced (see *Figure 5*).

A steep line represents a deep-flighted screw. A flatter line is typical of a shallow-flighted screw. From this plot, even without specific numbers assigned, it can be seen that there will be a wider variation in output with different die openings with the deeper screw than with the shallow screw. The deep screw will show a greater effect on output as screens become plugged. It should be realized that quality does not enter into these plots, but is a definite limitation to the process, as is also stock temperature.

If several different screws are used with a given die opening and the operating points connected, a die characteristic line is constructed. In actual practice, this line has a slight curve at lower pressures. From this type of plot it can be seen that the deep-flighted screw gives maximum output with low pressure dies, but that the shallow-flighted screw gives maximum output with high pressure dies.

Using the same type of analysis, the effect of screw cooling can be seen. When screw cooling is used, it is possible to change the screw characteristics to that resembling a shallower flighted screw. The cooling reduces the viscosity of the melt near the root and has the same effect as a shallow-flighted screw. In some instances, stock temperature is increased by this technique and, therefore, should not be confused with a means of cooling the plastic stock temperature.

As rpm is increased, the screw characteristic line moves up essentially parallel, thus resulting in higher output and pressures.

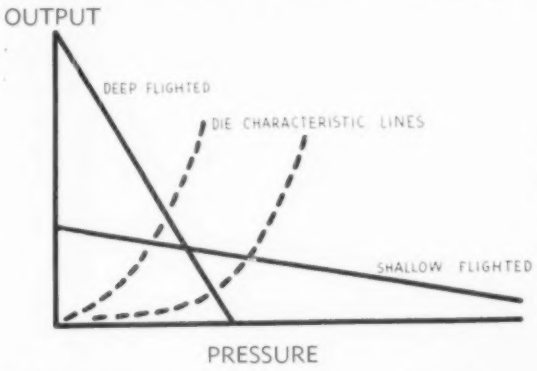

Figure 5. Plotting output and pressure for various die openings gives screw characteristic lines

High-Speed Extrusion

High-speed extrusion generally refers to screw speeds in the order of 150 to 250 rpm. In certain instances, screw speeds in excess of 500 rpm have been used. The interest in high speed is obvious when viewed in the light of the higher output obtainable. The problem of stock temperature control at high speeds becomes a problem. This was touched on briefly previously and is the so-called adiabatic extrusion. Because the heat is all from friction and instruments are no longer able to control temperatures, their physical changes must be made either to the die or screw in order to change temperatures. In an application such as blow molding, high speed extrusion does not appear to be practical, based on present know-how.

Another subject often discussed is valved extrusion. This refers to the use of a variable restriction between die and extruder. It has been shown that both higher outputs and better quality can be obtained by this technique. Raising the pressure pushes the melt zone further back in the extruder, resulting in additional working on the plastic. This gives better quality, permitting higher screw speeds. The final result is actually a higher quality and higher output. Unfortunately, once again stock temperature increases, and consequently valved extrusion is of limited value to the blow molder.

Table 2. Flow in the Extruder

Drag Flow	Forward Component—Theoretical Output of Extruder Without Die
Pressure Flow	As a Result of the Resistance Against Which the Screw is Operating . . . . Either as Forward or Back Flow
Leakage Flow	The Leakage Over Flight Lands . . . . Reduces Output

—— ■ ——

Edited by **Bruce H. Maddock**
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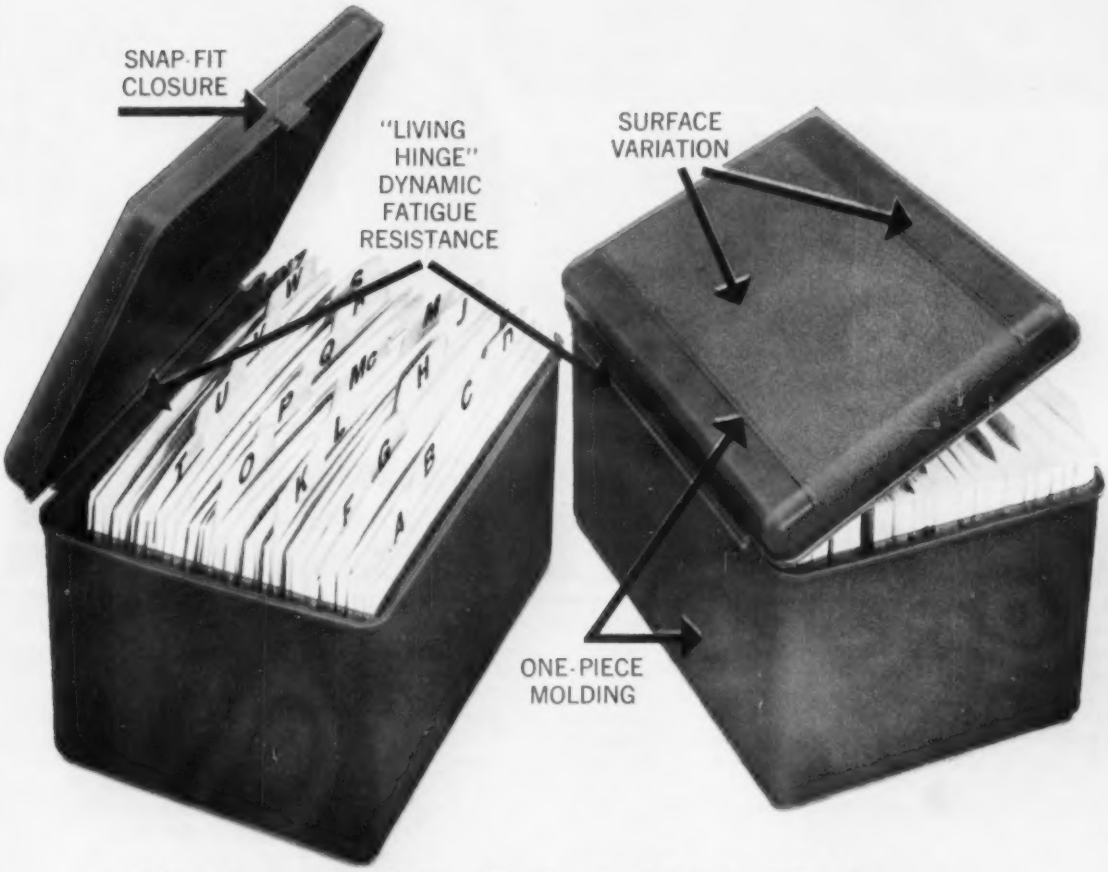

File box with "living hinge" shows design versatility of Escon® polypropylene

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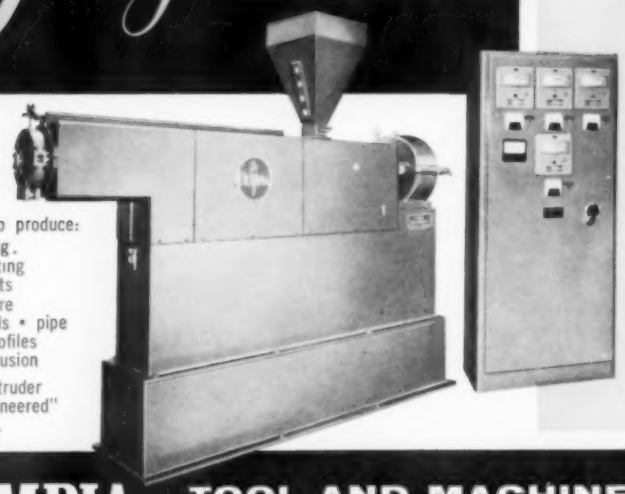

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OUTLINE OF PROGRAM

Fibrous glass is one of the strongest lightweight materials presently available in large quantities at a relatively low cost. Its use as a reinforcement for rigid polymer matrices has created a new class of materials of unique value in a wide variety of applications; included among the latter are aircraft, piping, pressure vessels, space vehicles, building components, chemical and ventilation apparatus, processing equipment automotive assemblies and many others. Despite this use growth, however, many aspects of fiberglass reinforced plastics remain poorly understood. For example, the role which glass surface treatment plays is not clear; techniques of handling and placing the reinforcing fibers are many and varied; the proper criteria for resin selection are ambiguous; realistic and informative test methods remain both controversial and elusive; design and stress analysis procedures are not well understood.

The purpose of this Special Summer Program is to examine the most recent research, development and applications advances in the field and to discuss the results of current work being carried out at the Institute and elsewhere. It is planned for technically trained personnel interested in the scientific and engineering aspects of fiberglass reinforced plastics: those engaged in the research, development, design, testing and use of this class of materials.

Topics to be discussed include:

1. Influence of resin characteristics.
2. Glass-polymer interface reactions.
3. Electron microscope studies of finish agent deposition.
4. Long-time mechanical behavior.
5. Fundamental aspects of adhesion.
6. Shrinkage pressure effects in polymer-filament systems.
7. Test methods for filament-wound structures.
8. Optimization of structural sandwich design.
9. Architectural uses of reinforced plastics.
10. Mechanical test methods and properties.
11. Continuous production of filament-wound articles.

Daily sessions will held 9:00 AM to 12:30 PM and from 1:30 to 4:30 PM; the session will close at 1:00 PM, Friday, June 23, 1961 to permit convenient travel arrangements. Tuition for this Special Summer Program is $200.00, due and payable upon notification of admission. Academic credit is not offered.

STAFF

The Program will be presented by the M.I.T. Plastics Research Laboratory of the Department of Civil and Sanitary Engineering under the supervision of Professor Frederick J. McGarry. Other Institute contributors will include Professor Albert G. H. Dietz, Dr. Jacob J. Bikerman, Dr. Rodney D. Andrews, Jr., and Professor Frank J. Heger Among the invited guest lecturers also participating in the Program are the following:

Dr. Harry J. Dietrick—B. F. Goodrich Research Center
Solomon Goldfein—U.S. Army Engineer Research & Development Laboratory
Dr. Kurt Gutfreund—Armour Research Foundation
Henry A. Perry, Jr.—Naval Ordnance Laboratory
Arthur L. Smith—Owens-Corning Fiberglas Corporation
Samuel Sterman—Union Carbide Corporation

THE SCIENCE OF ADHESION

June 26-30, 1961

OUTLINE OF PROGRAM

The number of adhesives available to a user and the number of operations in which adhesives are used have rapidly expanded in the last fifteen years. This growth of the industrial importance of adhesive joints was accompanied by an advance in our understanding of their nature. A review of the present knowledge of adhesion will be presented by the Plastics Research Laboratory of the Massachusetts Institute of Technology in a Special Summer Program on The Science of Adhesion from June 26 through June 30, 1961.

The following topics, among others, will be discussed:

Solid surfaces	Types of adhesives
Application of adhesives	Stresses in adhesive joints
Wetting	Non-destructive testing
Tackiness	Destructive testing
Preparation of solids for glueing	Adhesion in reinforced joints
Setting	Theory of adhesive joints

Tuition for this Special Summer Session is $200.00, due and payable upon notification of admission. Academic credit is not offered.

STAFF

The Session is organized by the Plastics Research Laboratory of the Department of Civil and Sanitary Engineering. The staff members who will participate are:

Albert G. H. Dietz—Professor of Building Engineering
Frederick J. McGarry—Associate Professor of Materials
Jacob J. Bikerman—Supervisor, Adhesives Laboratory

The special guest lecturers will include, among others:

C. A. Dahlquist	A. A. Marra
Minnesota Mining & Manufacturing Co.	University of Michigan
N. J. DeLollis	J. F. Murphy
Sandia Corporation	Olin Mathieson Chemical Corp.
J. L. Lubkin	
American Machine & Foundry Co.	

J. S. Malott

CTL Division, Studebaker-Packard Corporation

REINFORCED PLASTICS

The Ablation Heat Shield

The use of reinforced plastics in rocketry-theory and practice

This article is a State of the Art report dealing with the ablation heat shield in theory, design, and fabrication. Today the missile and space age is demanding a new domain of heat resistance. Theoretical concepts, material combinations and experimental techniques of fabrication are being developed. The thermal protection of re-entry vehicles is one of the greatest challenges in the development of missiles and space vehicles. Early experiments conducted by the Structures & Mechanics Laboratory at the Army Ballistic Missile Agency, Redstone Arsenal (1) indicated that commercial grade fiber glass impregnated with Melamine resins could withstand rocket burner exhaust gas temperatures for several seconds with very little damage. Although the material was never employed (2), the experimentation led to subsequent studies of ablating types of nose cone insulation and the successful re-entry of the Jupiter-C and the full scale Jupiter nose cone on May 18, 1958.

Before discussing the materials employed in re-entry heat shielding, let us examine the theory behind their selection. The definitions presented will not involve the theoretical calculations supporting this information; rather, the ablation process has been reduced to its basic concept (3). A missile nose cone or a satellite vehicle encounters severe aerodynamic heating when re-entering Earth's atmosphere. This condition arises primarily as a result of the compression of air molecules ahead of the vehicle and the conversion of molecular kinetic energy into thermal energy. We are then dealing with a gaseous boundary layer temperature in the order of 9,000 to 12,000°F. being encountered at the nose or stagnation point on the re-entry vehicle. This aerodynamic heating increases with both flight velocity and air density. Therefore, it is most intense when a high velocity persists into the lower atmosphere. The rate of this aerodynamic heating to the vehicle varies as a result of the vehicle's ballistic configuration. The main factors which influence this ballistic parameter are re-entry angle, flight velocity, altitude, and the lift and drag forces. Extensive investigation has been conducted in regard to four methods of thermal protection of re-entry vehicles. These methods involve solid and liquid heat sink, transpiration cooling, radiant cooling and ablative cooling.

The results of theoretical and experimental work indicate that each of these protective systems must be employed in a specific thermal environment. Since our interests lie in the use of reinforced plastic materials for re-entry applications, this discussion will be confined to the ablation process, the most reliable and extensively used system. Its wide use is a result of the design simplicity of the system and the efficiency of materials to absorb and dissipate heat.

What is Ablation?

Basically, ablative cooling is a complex process whereby materials undergo degradation, with attendant sacrificial removal of surface material. The physical aspects of this process are illustrated in *Figure 1*. This illustration is typical of the ab-

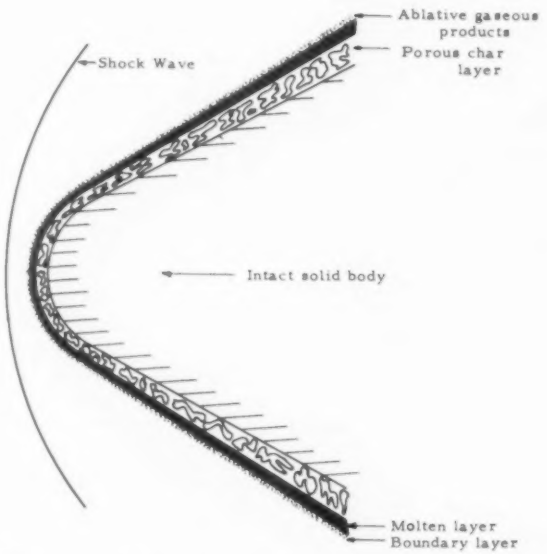


Figure 1. Diagrammatic representation of the ablation process

lation process for fiber glass-phenolic, asbestos-phenolic combination. Since the thermal protective material absorbs the incident heat as the temperature is raised, the low diffusivity of the plastic prevents appreciable conduction into the vehicle; thus, surface temperatures rise rapidly. At this point, the following chemical and physical reactions are initiated and the thermal ablation begins.

Organic components present in the phenolic resin, which is the binder between the reinforcement, are pyrolized or burned and, therefore, various gaseous products and carbon char layers are formed. These gases are injected into the boundary layer and envelop the ablating surface in a layer of relatively cool gas. The temperatures outside this gaseous boundary layer may reach as high as 30,000°F. (4), whereas inner face between the gaseous and liquid boundary layers may be as low as 3,000 to 4,000°F. If aerodynamic conditions are suitable, the carbon char is retained on the surface, further insulating the re-entry body.

The inorganic components, in the form of the reinforcing agent, or filler, will undergo a phase change from a solid state to a liquid and appear on the surface in the form of film or hollow beads. A small percentage of this melt is vaporized or removed from the surface by the air stream. The materials which are applied in ablation applications are generally defined in terms of their effective heat of ablation. This is the ability of the plastic material to absorb and dissipate heat. Various resin and reinforcement combinations have different effective heats of ablation; therefore, they must be applied properly in order to take advantage of the entire ablation process. This effective heat of ablation is expressed in BTU's/lb. It may generally be stated that as the heat flux to the body expressed in BTU's/ft² sec. is increased, the effective heat of ablation of the materials is also increased.

Ablation Materials

The material combinations most widely used in re-entry applications are Refrasil (the trade name for refractory silica), fiber glass, and asbestos. All of these reinforcements are used in combination with various phenolic resin systems. These materials are available in cloth or mat form for laminating, as well as chopped or macerated form for high pressure compression molding. Since all the materials employed are a combination of an organic binder and an inorganic reinforcement, all will exhibit a definite grain orientation. In a laminate, the direction of grain may be altered at will. The resin or fiber selection, the reinforcement orientation, as well as the fabrication techniques employed will determine the effectiveness of the ablation system.

As a result of our work in the field of re-entry, we have derived the following basic insulation and ablation principles (5):

1. A change in density of the molded fiber reinforced product exerts a major effect upon the ablation qualities. As a general rule, a decided improvement is experienced in all orientation configurations as the density is increased.

2. Orientation of grain or reinforcement affects the ablation system with more satisfactory conditions occurring when laminations are arranged in a fashion other than parallel to the gas flow.

3. The effect of resin content, while minor, does contribute to the improvement of the ablation system. This improvement generally occurs as resin content is reduced; however, we must work within practical limits.

4. The fiber reinforcement selected contributes to the resistance of high temperature-high velocity gas flow and has a decided effect upon the thermal coefficient of expansion and thermal conductivity. The degree of effect is generally dependent upon the melting temperature of the fiber, itself. A material which will melt at low temperature has greater ablative efficiency at low temperatures, with the reverse also being true.

5. The viscosity of the reinforcement in liquid state has a decided effect upon the ablation qualities.

Figure 2 will assist in the definition of various reinforcement configurations and their resultant operation. Detail "A" shows a parallel layup or laminations molded parallel to the gas flow. Detail "B" shows laminations arranged end grain or normal to the gas flow. Detail "C" shows the shingle pattern with laminations canted in the direction of the gas flow. Detail "D" shows the random condition experienced in the use of molding compounds.

In the parallel system, the fiber reinforcement is uninterrupted and capable of carrying high loads, whereas in end grain layup and shingle layup, the short fibers are more susceptible to failure. Under some conditions of stress, the loads are primarily accepted by the resin binder, itself, which is inherently poor. Thus, the resin becomes the weak link in the system.

In Detail "C", shingle lamination under tensile conditions, the resin, although in tension for a given thickness of material, exhibits a far greater area capable of accepting a given load. This is true, due to the fiber's being oriented so that the resin falls on the hypotenuse of the load carrying triangle, rather than on the short leg. The properties of the random pattern established in Detail "D", having fibers working in every direction, present ablative qualities which are subject to variation and may become a problem in shock or turbulent areas. It should be noted as a general rule, however, that the relatively low load carrying capability of the thermal protection does not present any particular problems inasmuch as the substructure or supporting member, whether reinforced plastic or metal, is designed to support the heat shield aerodynamic loads, as well as any payload which is carried by the re-entry vehicle.

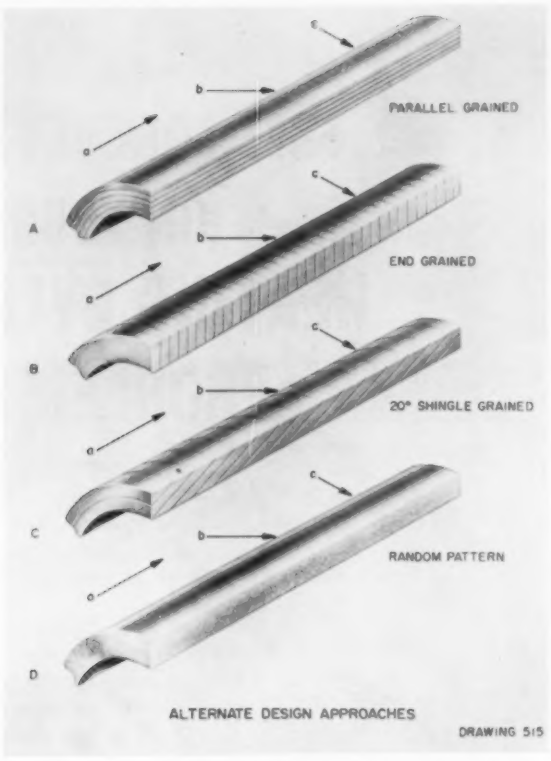
If *Figure 2* is examined with reference to conditions of gas flow (indicated as small arrows a, b, c) with reference to the various reinforcement orientations, you will note that ablation conditions under 45° and 90° gas impingement on the parallel laminate are improved, whereas in the end grain orientation, the possibilities for failure are greater as the high velocity gases tend to load the fibers in their poorest load carrying direction. This condition does not exist in the shingle pattern; therefore, the possibility for failure is remote. Ablation rates of the random fiber orientation are increased, however, as the short fibers are readily plucked from the resin bond. It should be noted that it is entirely possible, under turbulent flow conditions such as reattachment of the shock wave, for all three general directions of gas flow to occur. The physical data presented in the *Table* represent the combination of Refrasil and a CTL phenolic resin system.

As mentioned, the thermal protective material is generally not considered a load carrying member but is used in connection with other structures. The most common of these would be aluminum or magnesium and, in the more sophisticated approaches, reinforced plastics.

The Fabricating Techniques

In the manufacture of re-entry heat shielding, there are basically three fabrication techniques employed. They are (1) bag molding, (2) augmented bag molding, and (3) high pressure molding. Bag

Figure 2. Various reinforcement configurations and resultant performance



molding is a process in which many of the various reinforcement and resin laminating material combinations may be employed. The desired material is laminated over a male form or in a female form which yields the desired configuration. A Dacron neoprene or similar type bag material is placed around the completed laminate so as to form an envelope. Vacuum is drawn on the entire assembly while it is placed in an oven and subjected to sufficient temperature to cure the resin. In the use of this process, it is generally necessary to machine or hand finish the surface which is in contact with the bagging material. The surface in contact with the mold is generally acceptable as molded. The second process, augmented bag molding, is performed like the bag molding operation; however, the laminated part is placed in an autoclave for application of pressure in addition to vacuum. This additional pressure will range from 50 to 150 lbs./sq. in. and the cure temperature is achieved through the use of steam coils in the autoclave. The augmented bag molding process is used for fabrications requiring part density higher than the bag molding technique will yield. The third basic technique is high pressure molding. With this technique impregnated cloth, as well as a wide variety of molding compounds, are employed, ranging from chopped and macerated glass or Refrasil cloth to long and short fiber asbestos molding compounds. The prime requirement which is common in the use of all these materials is a high quality, precision machined and finished matched mold for pressures ranging from 1 to 5,000 psi. This process will yield parts of optimum density and ablation resistance.

The advantages of the bag molding and augmented bag molding processes are obvious. Since they require a minimum of tooling, they lend themselves well to the relatively low production quantities encountered in the missile industry and also permit rapid fabrication and tooling modification to aid research and development programs.

An advanced development in the fabrication of re-entry vehicles is currently being employed. This process, tape winding, makes possible the application of thermal protective material directly to a substructure without the intermediate machining operations. Tape winding reduces considerably the tooling requirements, since it makes use of the substructure as a winding mandrel. We have developed several tape winding machines which are partially automated and are a great aid in the application of ablation materials.

Table 1. Physical Data for Combination of Refrasil and a CTL Phenolic Resin System

Data Chart	A	B	C	D
Thermal Coefficient of Expansion (Primary Direction x 10 —6) (in/in/°F)	6.26	25.9	9.91	8.0
Ablation Rate at High Temp.	Good	Excellent	Excellent	Fair
Ablation Rate at Moderate Temp.	Poor	Excellent	Excellent	Good
Surface After Ablation	Rough	Smooth	Smooth	Smooth
Emissivity	.85	.85	.85	.85
Thermal Conductivity (BTU-in/hr. sq. ft. °F)	2.0	6.0	2.9	2.0
Tensile Strength (Room Temp.) psi	23,225	1,495	4,470	6,000
Tensile Strength (500°F) psi	21,025	718	3,140	2,900
Flexural Strength (Room Temp.) psi	49,150	5,105	7,295	15,000
Flexural Modulus (X 10) (Room Temp.) psi	2.3	0.7	1.12	
Flexural Ultimate (500°F) psi	26,725	2,623	5,520	9,000
Flexural Modulus (X 10) (500°F) psi	1.83	<.1	.65	
Columnar Compression (Room Temp.) psi	37,150	60,000	7,745	12,000
Columnar Compression (500°F) psi	16,500	35,400	5,725	5,244

Literature References

1. Lucas, W. R., and J. E. Kingsbury, "A Brief Review of the ABMA Ablation Materials Program," February, 1960, WADD Conference.
2. Silbernagel, R. E., "Development of Glass Reinforced Plastic Materials for Re-Entry Protection of Ballistic Missiles"—CTL—Aug., '60.
3. Schmidt, Donald L., "Thermal Parameters of Re-Entry Ablative Plastics," WADD—February, 1960 WADD Conference.
4. Biedenkapp, D. C., CTL—Personal Contact.
5. Warnken, E. P., CTL President (Technical Library).

edited by **George Lubin,**
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For more than ten years IMS has been the injection industry's clearing house on heating cylinder complaints of all kinds. Next time you have a press down for heater trouble or when you run into molding problems with the heat chamber, call IMS for an analysis of your specific difficulties.

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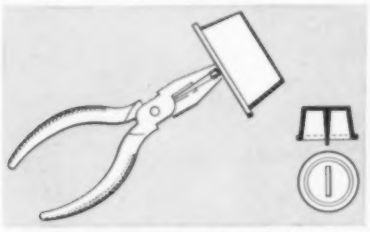
U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

MAY, 1961 — U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation — 99 Park Ave., N. Y. 16, N. Y.

Packaging Notes

Polyethylene pull plugs have fixed place to grip, so they're easy to remove and install with either fingers or pliers. Typical uses, according to the manufacturer, are: protection of pipe; tube and



hydraulic fittings; testing and shipping; sealing dirt-and moisture-catching openings; masking when spray painting, dipping or plating. Sizes range from ¼" to 3"; color is standard "caution" orange. Company also offers polyethylene tube caps, finishing flanges, flat washers.

Electronic bombardment of polyethylene bottles—to make their surface more receptive to printing inks—is claimed to be fast and efficient with an Italian-made machine about to be introduced in the U. S. A. Toys and other hollow polyethylene products, as well as bottles of any size or form, can be treated. Specifications include: output up to 2000 pieces per hour, depending upon product and model; built-in ventilation hood; push-button controls; spring-wire electrodes.

Automatic date and price coder developed specifically for the bakery trade is being marketed as an accessory to the maker's polyethylene bag-sealer. It reportedly stamps each sealed bag clearly and legibly, although package itself may be uneven. Imprinting foot actually moves the wrapped item, so spacing is of no importance.

BE SURE TO VISIT THE
U.S.I. EXHIBIT – BOOTH 304
NATIONAL PLASTICS
EXPOSITION
NEW YORK COLISEUM, JUNE 5-9
NEW YORK CITY

Polyethylene Tomorrow: Theme of U.S.I. Exhibit At S.P.I. Exposition

To Focus On New Opportunities For Profit

For a depth analysis of the problems and opportunities of processing with polyethylene in the years immediately ahead, visit U.S.I.'s Booth 304 at the 9th National Plastics Exposition. The show sponsored by the Society of the Plastics Industry, Inc., will be held June 5-9 at the New York Coliseum.

Market Advances Displayed

U.S.I. will provide dramatic market-by-market forecasts of polyethylene supply and demand through 1963. Specially-constructed displays will show increases anticipated in each of five areas—film extrusion, coating and laminations, injection and blow molding, wire coating and pipe extrusion, and molding with powdered polyethylene.

Breakthroughs Featured

Samples of important new polyethylene products made by the various processing techniques will be on display. Such products, which illustrate the versatility of polyethylene, are contributing substantially to market growth . . . creating new profit opportunities. Typical and on exhibit for the first time: boats molded of U.S.I.'s "Microthene" finely-divided polyethylene resin. Other items show applications ranging from packaging to construction to toy and novelty products.

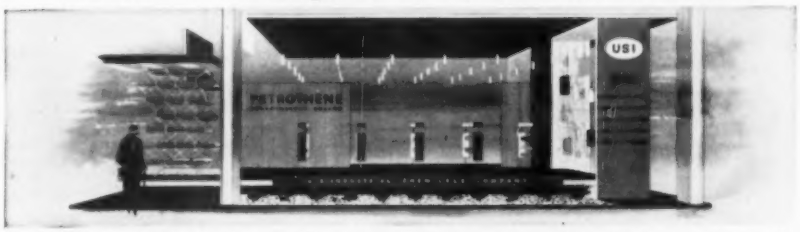
Technical Experts to Interpret

U.S.I.'s technical service representatives and market analysts will be on hand to answer questions and interpret trends. These experts have the know-how to help solve production problems and help guide processors to maximum profit.

Products Arrive As Shipped In Polyethylene-Lined Mailing Bags

Polyethylene-lined mailing bags are ideal for shipping samples or small quantities of products requiring moisture protection or retention. Dehydrated food, flour and chemicals are examples of the former; plant food, of the latter. Filling is manual or automatic. Liner, which extends slightly above bag mouth, is banded, wire-tied, or heat-sealed closed; then pushed down into cotton outer bag.

U.S.I. To Participate In British Plastics Show



New equipment will be U.S.I.'s main attraction at INTERPLAS 1961, the British Plastics Exposition to be held at the Olympia, London, England, June 21-July 1. U.S.I. will occupy Booth B-209, on the first floor of Hall B (National).

On center stage will be the "MA Packaging System" which provides inexpensive, in-plant packaging for a variety of products. This system shows promise of increasing the market for polyethylene film. The M A System utilizing a shrink tunnel will be packaging the International Edition of the New York Times as a gift to visitors to the booth.

Samples of other polyethylene products, too, will be shown: blown and cast film; rolls of polyethylene-coated substrates—foil, paper, polyester and cellophane; injection molded products; such new blow-molded items as a miniature wine flask, toy doll parts and garden ornaments.

Also offered for the first time will be a new edition of U.S.I.'s detailed processing guide for all polyethylene processors. It is published in English and will soon be available in German and Spanish as well.

U.S.I.

Series VI, No. 3

POLYETHYLENE PROCESSING TIPS

TRANSMISSION OF MOISTURE VAPOR THROUGH POLYETHYLENE FILMS AND COATED PAPER

Polyethylene film and coated paper are often selected as packaging and construction materials principally because they provide a moisture barrier.

In packaging hygroscopic materials such as powdered foods, sugar, flour and dry chemicals, moisture pick-up must be prevented. Metals, too, require protection from moisture, which accelerates corrosion.

In construction work, polyethylene film and coated paper are used to seal off moisture under buildings, in sidewalls, and under concrete floors and driveways.

In some cases, moisture *loss*, rather than pick-up, may be the problem. Bread and baked goods need moisture to remain fresh. Cellulose sponges are packaged damp to keep them soft and pliable, and this moisture must be retained during the shelf life of the package.

Conditions Determine Requirements

For any packaging application, the required degree of resistance to moisture penetration depends on the nature of the product and where it is stored and used. In selecting a particular polyethylene film or coated substrate, one should consider: (1) the amount of moisture gain or loss allowable through the polyethylene and (2) the environmental conditions which will be encountered. These will determine the permissible moisture vapor transmission rate for the film. With many products, moisture barrier requirements may be so non-critical that any polyethylene film or coated substrate that can be used to package them will also provide a satisfactory moisture barrier. With many packages, seams, corners, or stitching may be a bigger factor with respect to moisture vapor transmission than the barrier properties of the polyethylene itself.

Factors in Moisture Vapor Transmission

By definition, moisture vapor transmission (MVT) is the rate of water vapor permeation through a barrier under given conditions of temperature and relative humidity. MVT is measured in grams of water vapor penetrating one square meter of film or coated paper in 24 hours. Test conditions (ASTM E 96-53T) call for 73°F temperature, with 50% relative humidity on one side of the sample and less than 5% on the other.

Figure 1 shows the effect of film density and environmental temperatures on the MVT rates of 1-mil film. To decrease the MVT rate, it is necessary to increase film density or decrease the environmental temperature.

Figure 2 shows the effect of film thickness and coating weight on MVT for polyethylene resins of .920 g/cc density.

FIGURE 1

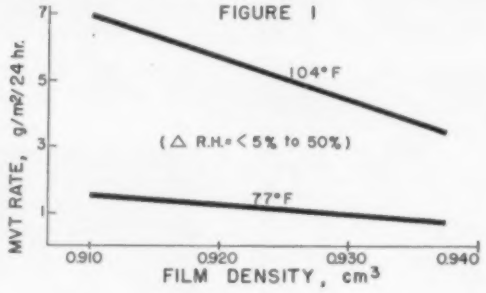
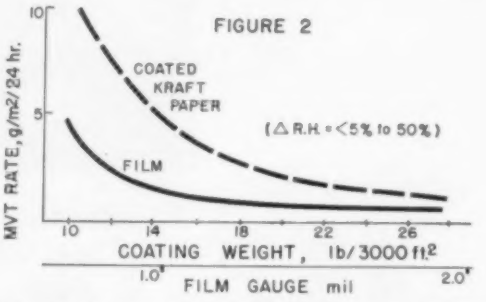


FIGURE 2



The higher vapor transmission of coated paper is due primarily to "wicking," for at low coating weights paper fibers may extend through the thin coating. At higher coating weights, "wicking" will not occur, and polyethylene films and coatings of equal thickness will have essentially the same MVT rates. Barrier properties of the substrate are also important. Foil, for example, has a very low MVT rate and is often used in laminated materials for critical military packaging.

The greater the difference in relative humidity across the barrier, the higher the MVT rate. Thus, dry packaged materials will need more protection in high-humidity environments. MVT rates vary linearly with the difference in partial pressures of water vapor across the barrier, except for thin coatings where "wicking" may occur.

U.S.I. Help on MVT Problems

Greater economy may well result from use of the proper film density and thickness. For assistance in finding the best resin or film for given applications, contact the nearest U.S.I. Sales Office. Your problem will be referred promptly to U.S.I.'s Technical Service Department.

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Allen V. Astin,

Director, National Bureau of Standards

STANDARDS FOR PLASTICS

Physical Measurement-Challenge to Science and Engineering

Two quotations will establish the philosophical frame for this article. The first is from Plato's Republic where Socrates is quoted as saying:

> We are exposed to many delusions. But reason thus confused by false appearances is beautifully restored by measuring, numbering and weighing . . . By this is eliminated the rule of the senses over us. We disregard now sensual impression of magnitude, of number and weight of the objects, but calculate, measure and weigh them. And it is this part, which relies upon measuring and calculation, which is the better part of the soul.

Here Socrates, who often considered the differences between reality and what we think is reality in nature, has recognized the value of measurement as a means of objective perception.

The second quotation is more familiar. It is Lord Kelvin's famous statement:

> I often say that when you can measure what you are speaking about and express it in numbers you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.

These quotations emphasize the fundamental relationship between knowledge and measurement. It must follow that an exchange of understanding about physical phenomena between scientists or among laboratories is based upon objective measurement and upon the communication of observations and conclusions in terms which are consistent and commonly agreed to. It should also go without saying that the more accurate your measurement technique and the more precise your data the better will be the knowledge of nature, the less ambiguous will be the communication of that knowledge, and the greater will be the opportunity of understanding that knowledge.

Very often advances in measurement methods or instrumentation have unlocked vast areas of the unknown, have provided the means for new exploration, and have served as the bases for entirely new fields of scientific investigations and specifications. The telescope, the microscope, the caliper, the electronic amplifier, the quartz crystal, the oscilloscope, the spectrometer, the interferometer and hundreds of other devices and techniques of measurement, such as radar, telemetry, or microphotography, have contributed to our ability to understand more about more of the world of nature. Important also is the fact that increases in the accuracy of measurement brought about by grad-

Special Note

The hard core of all science and engineering and the solid basis of commercial activities is a standard, sound and sufficient system of measurement. Progress in science and engineering reduces the adequacy of measurements that were formerly acceptable. This rate of measurement obsolescence has been accentuated by the great advances in science and engineering since the last war. The needed advances in measurement science are of interest to plastics engineers, scientists, technologists, and business leaders because plastics products enter into practically all phases of engineering and commerce. This paper, written by the head of the leading laboratory in the U.S.A. concerned with methods of measurement and our measurement system, presents some of the underlying philosophy of physical measurements and discusses some of the areas wherein our present methods and standards are no longer adequate. Frank W. Reinhart, Feature Editor.

ual elimination or reduction of sources of error or uncertainty give us more complete and more confident knowledge of physical properties and increased ability to use that knowledge for our material benefit. Most often the devices and processes of physical measurement have given us knowledge through precision—precision knowledge.

To precision knowledge our technology is indebted. It may be stated that our ability to control or to make use of nature's resources is directly dependent upon the degree of our understanding and on our ability to practice precision measurement. The gaps between basic data and applied research and development are functions of precision knowledge and advanced measurement processes.

Therefore, there is implicit in the opening quotations of this paper a homocentric or utilitarian notion which links the measurement processes to the utilization of knowledge for man's benefit. This notion should be made explicit. Lord Kelvin's aphorism might be revised to include the view of technology in the following manner:

> That when you can measure a property of something you are interested in and express it in numbers or some precise form, you know something about it and therefore may apply it; but when you cannot measure it, when you cannot express it in numbers or some precise form, your knowledge is of a meager and unsatisfactory kind and your ability to use such knowledge is limited. You may be in the early stages of craftmanship but you have scarcely, in your operations, advanced to the stage of engineering.

In this revised statement the immediate service of measurement to production as well as to science is readily recognized. Measurement thus becomes the language of science as well as the means for translating research for the advancement of our economic welfare. Measurement allows us to observe what was heretofore unobservable and this same process lets us take what is newly known and convert it to some tangible benefit. In today's technology we find a concerted effort to provide precision control along the whole of production. Industries are concentrating on the conversion to control equipment which will insure that not only will the finished product meet operating specifications but that the raw materials and their properties will be rigidly controlled during the processing. Such control can only be achieved through adequate instrumentation and the proper application of measurement. Measurement thus has an important bearing on the progress of science and technology. And when we speak of the frontiers of measurement, it is possible to select almost any point along the line from basic research to production and properly consider that such a point exists on the edge of precision knowledge.

For the purposes of this paper, science and technology are divided into four arbitrary areas as follows: First, the newer fields of scientific investigation, such as plasma physics; second, the established areas of research; third, the newer fields of technology, such as rocket and missile development; and fourth, the established fields of technology where precision measurement may provide improved performance and reduced costs. These distinctions, however arbitrary, will prove useful in describing the wide range of opportunity for improved measurement. Frontiers exist all along the line, and advances at any point may be useful to all points. A number of basic advances began with innovations at the applied research and development level of technology. The history of basic research is filled with spectacular advances brought about by increased measurement precision. In some cases increased accuracy produced inconsistencies or paradoxes which required the evolution of totally new concepts for their resolution. Probably the most spectacular example is in the area of atomic weight measurements. Here successive increases in measurement precision led first to the concept of the periodic table, then after the resolution of intermediate problems, to the concept of isotopes and atomic numbers and still further along to the concept of packing fraction and the confirmation of the equivalence of mass and energy.

New Scientific Investigations

Look at some of these scientific and technological categories so that we may see some current examples of measurement frontiers. In the area of the newer basic scientific investigations, there comes immediately to mind an example which is close to the National Bureau of Standards (NBS). Recall the recent nuclear parity experiment which provided confirmation to the hypothesis of the Nobel laureates, Lee and Yang, that a long-held theory of nuclear symmetry had a questionable validity. Professors Lee and Yang astutely questioned this accepted theory and proposed some experiments to test it. It then became a problem for measurement, a most complex and delicate measurement problem which had to be solved in a decisive way. It required the capabilities of scientific specialists who could undertake precision measurement in a number of disciplines. The experiment took about six months to set up, run, and analyze. It is a clear case where precise measurement at a frontier of basic science gave new understanding. This reversal of a long-held physical theory is expected to contribute towards the unraveling of confusing data and speculation regarding the large number of fundamental nuclear particles. Today's confusion has been compounded by seemingly contradictory observations. In this field, measurement techniques of great novelty have been developed, but even greater ingenuity and precision is required to break through the present nuclear puzzle. Another interesting basic frontier of measurement exists in the field of ionizing radiation, namely, plasma physics. Lately the phenomena of ionized gases have been the subject of intense physical exploration. These ionized gases show great promise as sources of tremendous power and of serving as envelopes for great natural furnaces. It is apparent that in this field theory is running well ahead of measurement capabilities. The obstacle to significant experimentation in this area is the lag in the development of precise techniques for producing and controlling these phenomena in a laboratory. Although we recognize that there are tremendous heats and energies locked in these materials, we must treat the problem in relatively gross experiments until we achieve further advances in instrumentation.

Still another area of basic interest, possibly related to that of plasma physics, is the field which we are calling "free radicals." About five years ago, it was definitely established that highly unstable molecular fragments exist for minute fractions of time in nature. Up until recently, this phenomenon could not be adequately observed. Now we are in a better instrumented position not only to observe, but also to capture and create these fragments. Having come this far, we are still perplexed by the phenomena we are observing. This is a real problem for measurement scientists and there is a substantial effort in this direction. Recently, the NBS spearheaded a large cooperative effort, including a number of scientists from industry who joined us on loan from their organizations, to measure these phenomena in the laboratories throughout the country as well as at

NBS. Free radicals have opened up v..st possibilities for new studies of the molecular binding characteristics of nature and of untapped chemical energy sources. The measurement of these phenomena has been especially difficult, and substantial progress is directly dependent upon future refinement of our measurement techniques.

It should now be apparent that the frontiers of the basic sciences coincide with the frontiers of measurement. It confirms, or at least strengthens, the theorem that a measurement frontier may be found all along the line of research, yet it is surprising how often the role of measurement is underestimated in experimentation.

Established Areas of Research

In the second arbitrary category, that of the established fields of science, we also come up against some difficult measurement frontiers. In these fields, despite significant measurement advances we are faced with the continuing challenge for greater precision. And it is characteristic of this need that further progress is often most difficult, for having reached certain levels of measurement sophistication, further progress requires an extensive effort. This notion is more appreciated by technologists and scientists than by laymen. The popular look at research fails to appreciate that some of the most profound problems facing science are those related to achieving higher precision where substantial precision already exists.

A few illustrations will demonstrate this. The first example is the broad field of spectroscopy where advances in precision techniques have already provided the basis for most of our knowledge of molecular, atomic and nuclear structure. In spite of the great strides which have been made there are many problems whose solution would be accelerated by improved techniques of measurement, such as in beta ray, spectroscopy or infrared spectroscopy.

A second example in this group concerns time measurement techniques. Cesium beam and related devices, and masers are providing new opportunities for the accurate measurement of phenomena occurring in extremely short intervals or very minute rate changes of certain processes over longer periods. It now appears likely that it may soon be possible to put a sufficiently sensitive atomic clock in a satellite to provide a direct check on the postulate from the general theory of relativity concerning the influence of a gravitational field on atomic processes.

Another vital frontier is that of temperature, especially the extremes of temperature. Today's requirements for high temperature materials, high speeds and frictions, and increasing propulsion efficiencies have placed a premium on the extension of the temperature scale. Today's research requires instrumentation for making careful laboratory and field experiments to test high-heat systems under operating conditions. Here again is a case in which theoretical studies have advanced beyond precision measurement capabilities. Under controlled laboratory conditions, we can make high temperature measurements with some confidence up to about 6000°C, yet today we are talking about million degree temperatures and we hear of the possibility of controlled fusion furnaces.

At the other end of the temperature scale, there is a similar measurement challenge. Below four degrees absolute, there lies the vast field of cryogenic research and new prospects of low-temperature production processes, yet there are no fully adequate reference points in this segment of the temperature scale. Cryogenic temperatures provide us with a new way of studying normal phenomena. For this reason nuclear physicists, physicists, metallurgists, chemists, and engineers have entered into the field of low-temperature investigation. Yet these studies have hit discouraging and confusing snags because of the lack of these reference points and the inadequate precisions in today's low-temperature measurement techniques.

In this category, one of the measurement frontiers of current interest at NBS is the field of highly pure substances and materials. It has now become necessary to devise precision production and precision analytic techniques so as to exceed previously attainable purities, in some cases, by two orders of magnitude. What is even more difficult, it looks like technology will require that the new measurement and control techniques be suitable for largescale production processes. This is an area where the basic sciences and the world of technology exist in the closest proximity.

Usually in these established fields of science we find that measurement science lags behind the need. Very often the demand builds up to a point where the requirement for measurement advances and new instrumentation no longer can be resisted. In some ways this is unfortunate. Answering crash requirements is not the best way to solve perplexing measurement problems.

New Technology—Rockets and Missiles

In the third category, the newer areas of technology, the examples just given could well be included because these are areas where technologists press closely on the heels of scientists for more basic knowledge. There are numerous other activities which might also be classed as frontiers. Immediately there comes to mind the fields of space exploration, automation, and miniaturization. It may surprise some that space exploration is classed under technology but remember that measurement is our subject. Whole compendiums of basic space data must be collected and in this respect space studies belong in fundamental research. However, the measurement aspects are principally technological problems. In most cases, no new measurement principles are involved. From the point of view of basic science, one of the major opportunities that satellites afford is the placing of a measurement platform beyond the screen of the earth's atmosphere so that the universe may be viewed without highly restrictive blinders. The physical devices needed for such research are fairly understood despite the difficulty of getting them properly launched. So, the measurement aspects of space exploration belong at the moment largely to technology. As technological advances permit the placing on a routine basis of larger and more sophisticated satellites in orbit, or lunar and planetary probes in trajectory, there will be countless measurement opportunities. These undoubtedly will increase our knowledge in unpredictable directions except most certainly they will generate new measurement problems. From the strict point of scientific observation one would consider the launching of a manned space vehicle only when there is a measurement or control function required that can be made more efficiently and economically by man than by automatic instruments. In anticipation that this stage will sometime be reached, it is of course appropriate to consider at an early date possible solutions to the problem of placing man in space.

The field of automation is receiving a great deal of comment. A significant number of industries are studying the possibilities of introducing automated processes and are using them in business and production. The uses of measurement, feedback, and control for flexible mass production makes the promise of automation a bright one. It is still a frontier, however, because industry still has a long way to go. Measurement instrumen-

tation still has to be worked out for specific applications. Automation equipment is more often than not in the design stage. Computational and control techniques must be developed. And a rational system of interrelated instrumentation for total automated control processing has not been created. At this time it can be said with some certainty that the future of automation is very promising, but there still is a most important technological frontier to subdue.

The field of miniaturization is essentially a product of modern technology. Today's devices require that they be made up of a host of components and subdevices of reduced size but with no sacrifice of accuracy or performance. Achieving needed reductions of weight and size is itself an important measurement problem. Lately it has been noted that the successful miniaturization of a device very often is accompanied by longer life characteristics than its normal counterpart. This is probably due to the advanced measurement required to produce the mite. The pivots, bearings, gears and clutches that are essential components in many small instruments demand unusual fabrication and measurement. Controlling precision to a part in a thousand is obviously much more difficult on an object a tenth of an inch long than on an inch long object. Because miniaturization is so important to the future of instrumentation, it has double significance as a measurement frontier.

It should be emphasized that examples of measurement frontiers have been cited and no attempt has been made to be comprehensive. For example, reactor technology has its own frontier measurement problems. Reactors are in themselves devices for new types of investigations and measurements. Furthermore, the measurement and control problems associated with the use of reactors in industry are indeed a vast technological frontier.

Today's Technology

The last category, the area of established technology, is populated with changing measurement frontiers of new products and new production processes. Engineers, scientists, and technologists must be well aware of a vast number of special instrumentation needs. In this category, three special problems will be considered, namely, reliability, force measurement, and length measurement.

Component reliability is a problem as old as technology itself and as new as tomorrow's product. Recently the problem has increased in severity because technology has come to depend more and more upon a complex network of interrelated devices made up of thousands of components and hundreds of thousands of parts. When it is considered that the malfunction of a unit may detract from the operation of the system, we become aware of the need for rational approach to reliability. We must re-examine our notions of quality control, inspection, and precision measurement. We may have to rely upon continuously controlled production processes with the same degree of intricacy of machine inspection that can be expected in a total system after assembly. Here is a problem which design and structural engineers must cooperate in so that fundamental reliability can be built into unit parts in anticipation of ultimate use in complex systems. NBS is well aware of the importance of considering standards and measurement requirements as primary requirement of advanced design. We hope that all advanced planners of technology will become conscious of this relationship.

In the field of force measurement we find another frontier. Military agencies and space exploration are requiring initial thrusts approaching that of a million pounds and probably will exceed that requirement in the near future. Furthermore the devices for which such thrusts are needed also require that the force measuring devices be calibrated with precision accuracy. Unfortunately, this is another case where the demand has far preceded the measurement capability. Today, we can only provide direct comparison of force measuring devices with dead weight standards to a little over 100,000 pounds, about one-tenth of the requirement. The problem of providing indirect comparison and calibration services is indeed a measurement frontier.

At NBS, this is considered one of the high priority frontiers. NBS is actively engaged in providing interim service as required while developing plans for the creation in the not-too-distant future of a new one million pound dead weight device.

The final example comes from linear metrology. Here, because of strong pressures from industry, NBS is seeking improvements in gaging, calibration techniques, line standards and end standards. We are moving away from arbitrary physical standards towards a dependence on natural atomic constants. The time will come when the basic standards of length, mass, and time will be defined with greater precision in terms of natural constants. We are presently in a period of transition leading towards the establishment of basic standards of length and time defined according to specific atomic constants. In 1960, the international convention of nations adhering to the Treaty of the Meter defined the meter in terms of krypton 86. On the working level of linear measurement, NBS has been cooperating with industry in improving linear calibration devices. We hope to be in a position to calibrate master devices to one ten-millionth of an inch. This will enable production line tolerances of one-hundred-thousandth of an inch. This dividing the inch into the almost immeasurable is one of the most difficult frontiers of measurement.

This brings to an end the listing of today's measurements problems. They are only meant to illustrate the vitality and the critical role of measurement. Measurement is so much a part of human progress that it deserves special recognition. On other occasions I have indicated the desirability of creating a whole corps of measurement specialists and of introducing educational programs towards that end. This needs to be repeated here. Measurement and instrumentation should be considered as an area of specialization. It seems that we would be conserving human ingenuity if we would rely upon professional measurement scientists to provide the instrumentation and measurement techniques for the solution of many of the special scientific and engineering problems which exist within the compartments of today's research. Professional measurement scientists would concern themselves with the continuing advance of measurement and might even anticipate the demand for particular devices. They would be readily available to adapt techniques to new uses and would reduce the inefficiencies which occur when a nonspecialist takes time out to learn the business of precision measurement.

A good end for this paper is the same idea that started it. The frontiers of measurement are the frontiers of science and technology. In other words they are the frontiers of our knowledge of the physical world and of our ability to make constructive use of that knowledge.

***Editorial Note:** Except for minor editing this paper is a talk presented at the Annual Meeting of the Society of Automotive Engineers in January 1959. Excerpts from this paper were printed in the SAE Journal, March 1960, pages 26-28, under the title "Today's Measurements Units are Passé"*

Edited by **Frank W. Reinhart,**
National Bureau of Standards

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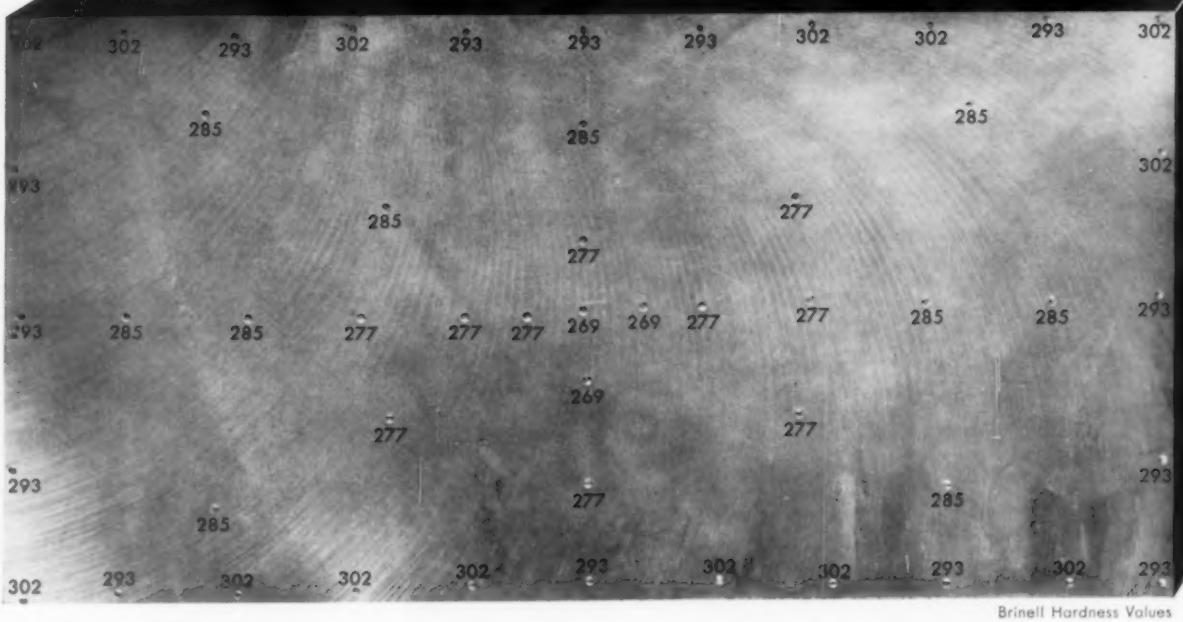

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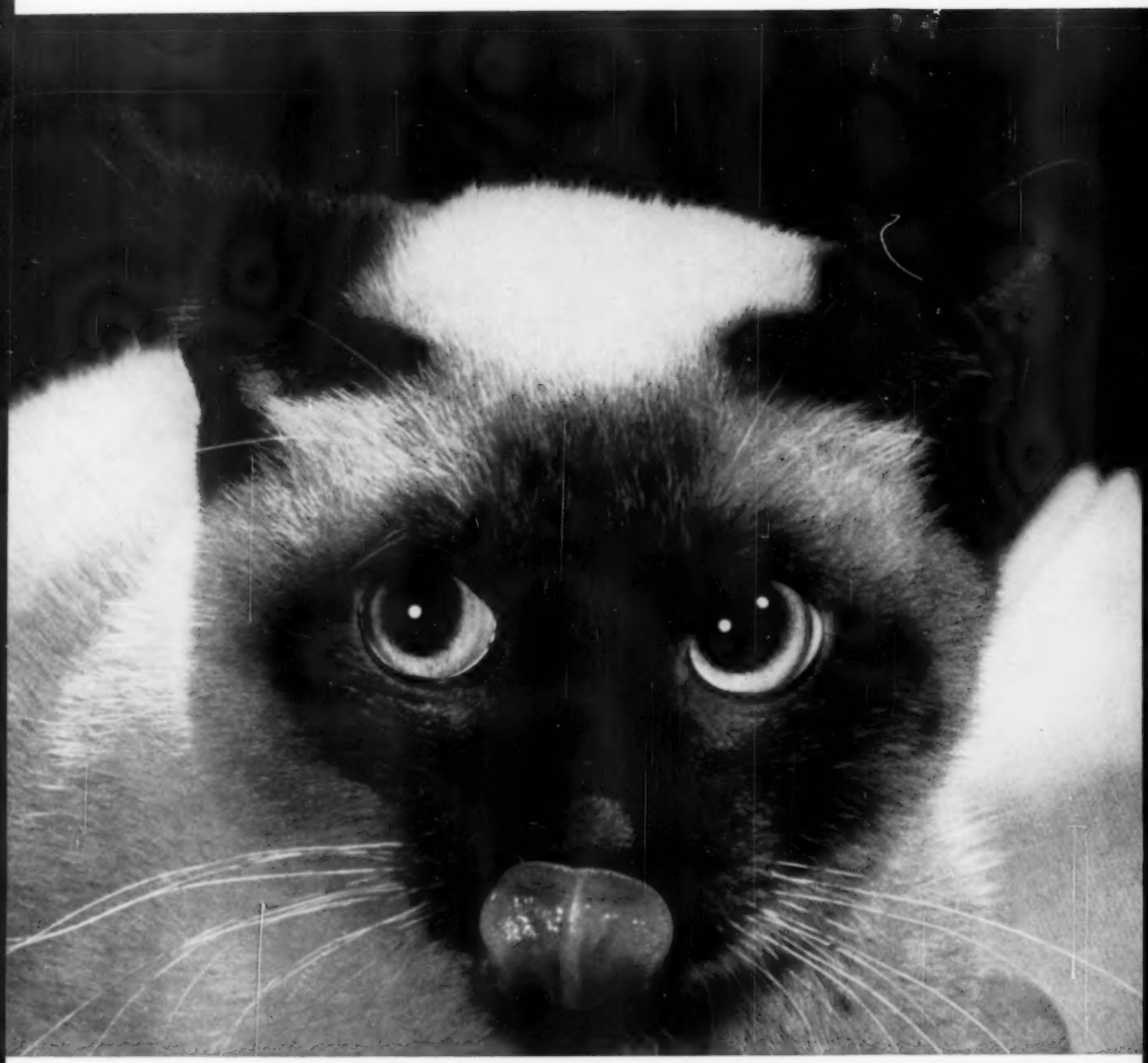

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Practical Phenolic Molding Techniques

E. W. Vaill
Union Carbide Plastics Co.

Operating details for automatic plunger molding. How optimum preform properties, mold design and operation can speed output and lower costs

Recent research in resin chemistry has made available phenolic molding materials which have rates of cure faster than can be handled by press operators on a semi-automatic basis. Therefore, in order to take maximum advantage of these faster cure rates and to reduce production costs, automatic molding by both the compression and plunger methods is becoming increasingly important.

Figure 1 can be used in calculating molding costs from seconds per cycles, cycles per hour, or molding costs per cycle. Since direct labor varies from plant to plant and direct overhead charges vary according to the size of press, we have calculated the chart using combined direct labor and overhead charges of $6.00, $8.00, and $10.00 per hour.

This chart can be used not only for reference but also to graphically demonstrate the reduction in production costs by the use of faster curing materials, either with or without preheating.

It also demonstrates the production cost savings by completely automatic molding which requires very little direct labor as compared to higher production costs of semi-automatic molding which requires considerable direct labor. Example: A molded part is being produced on a 60 second complete cycle on a semi-automatic press with direct labor. If the plant costs, including direct labor and overhead on the press are $8.00 per hour, the cost per heat is $0.132. If the same part were produced in an automatic press where there would be little direct labor and the mold cycle is still 60 seconds, the direct overhead would be approximately $6.00 per hour and the cost per heat would be $0.10. This is a cost saving of $0.032 per heat or $15.36 per eight hour shift.

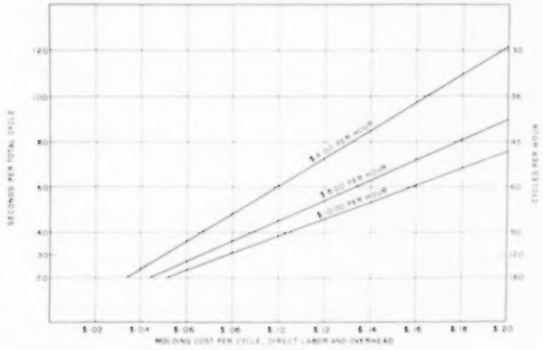

Figure 1. Compression and plunger molding production costs, showing reduction in cost at high output rates

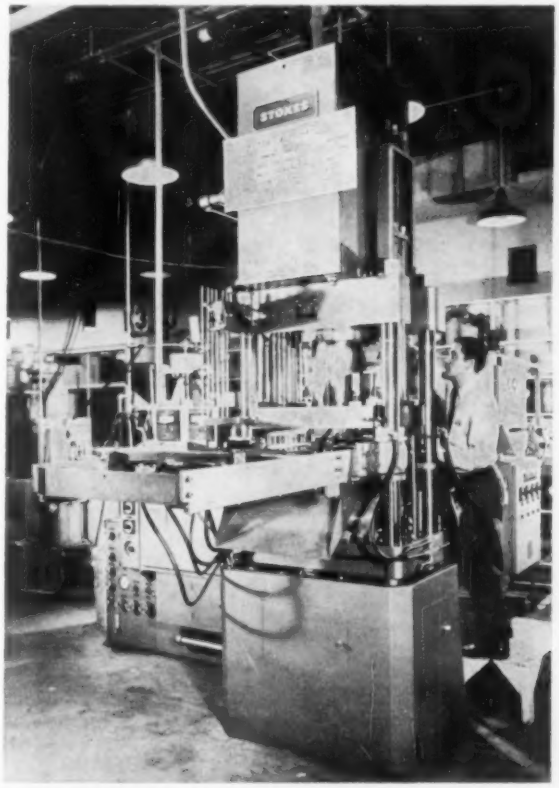

Figure 2. Stokes automatic compression and plunger molding press, 150 ton clamp, 50 ton bottom plunger ram

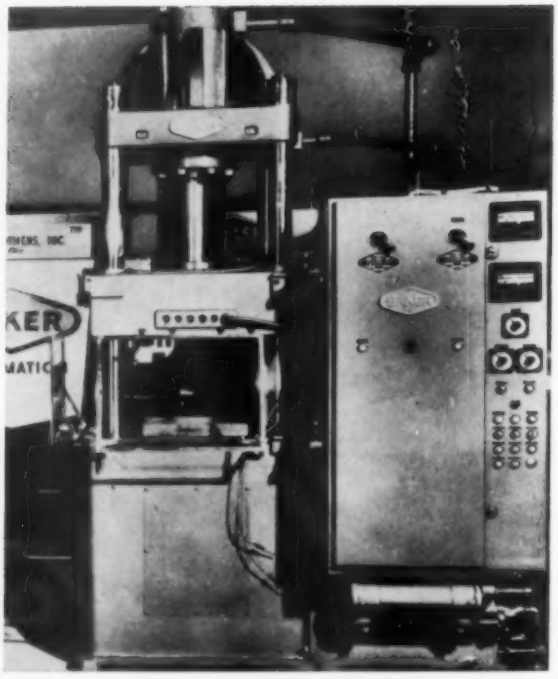

Figure 3. Baker Brothers Inc. automatic compression and plunger molding press—150 ton clamp, 50 ton bottom plunger ram

In automatic molding whether by the compression or plunger techniques, electronically preheated powder or preforms are recommended. By bringing the material preheat charge up to a temperature between 225-250°F. with a mold cavity temperature in the range of 325-350°F. the cure time of molded parts can be reduced by 20 to 40%.

Union Carbide Plastics Company has done considerable development work in automatic plunger molding. In the process developed, the preforms are charged into a Syntron vibrator hopper, and fed into a chute, from which they are carried down to a glassfiber loading plate which, in turn, is brought into position between the electrodes of the electronic preheater. From the preheater, the preforms are automatically transferred to the open mold and dropped into the plunger well located in the bottom half of the mold. It will be noted that the press in *Figure 2* is designed with a top clamping ram and bottom plunger ram. Another kind of press currently on the market (the "ram within a ram" type) has a bottom ram clamp. The plunger ram, mounted within the clamping ram, moves upward at the instant the mold becomes completely closed. In this type of molding, it is recommended that wherever possible, the molded parts be retained on the upper half of the mold when it opens in order that they may drop onto the discharge tray for removal from the mold. Other models of automatic plunger molding equipment are shown in *Figures 3* through *6*.

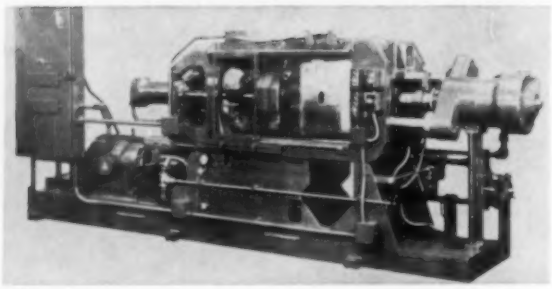

Figure 4. Lester-Phoenix automatic plunger molding machine with 400 ton clamp and 65 ton plunger ram

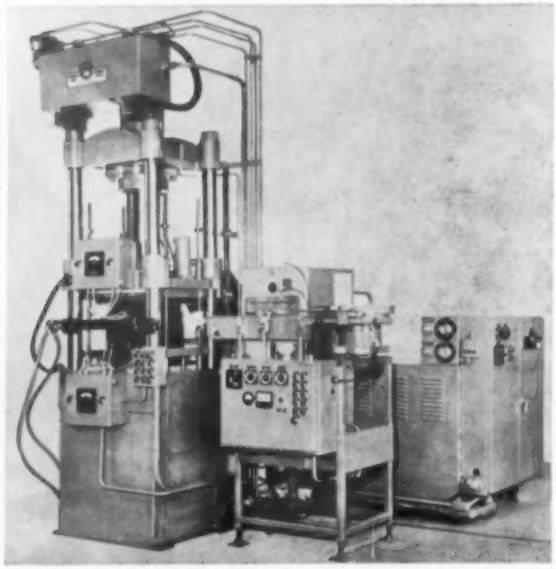

Figure 5. Rodgers Hydraulic Inc. automatic plunger molding press—150 ton clamp, 32 ton plunger ram

Preform Properties

The preform hardness of phenolic molding materials has a major effect on their radio frequency preheat characteristics. Measurement of the preform hardness with a Durometer "D" scale tester is a simple and accurate method of controlling preform hardness once the optimum hardness rating has been established for a given material and preform size. Controlled preform hardness and uniform, maximum preform temperature are essential to present day high production requirements of phenolic molded parts produced by the compression, plunger or closed mold methods (*Figure 7*). An earlier article in the SPE Journal describes the hardness measurement (2).

On the basis of this investigation and preform hardness tests made on materials being used in several molding plants, we recommend that the Durometer hardness of preforms on the D scale be maintained within the following range, with a limit of ±5 points once the optimum hardness has been determined.

	Preform Hardness Range
General-Purpose Phenolic Molding Materials	50-70
Mineral-Filled, Heat Resistant Phenolics	60-70
Improved-Impact, Cotton-Flock Filled Materials	50-60

Preform temperatures affect various molding characteristics. *Figure 8* shows how even moderate variations in the preform temperatures can cause substantial changes in minimum blister-free cure time. This chart was calculated with mold temperatures of 315°F. and 355°F. using a plunger molded cap as the test specimen. A multiple charge of preforms must be uniform in temperature if blistered

and undercured parts during the plunger molding cycle are to be avoided without lengthening the cure time. This is also true when preforms are heated for charging a multiple cavity compression mold.

Figure 9 demonstrates the effect of preform temperatures on the flow characteristics of the material. The pliability of the heated preforms determines the mold closing time which is a very important factor in attaining maximum productivity and complete fill-out of the molded part.

This uniformity of preform temperatures is also of vital importance when multiple preforms are charged into the well or pot of a transfer or plunger mold. Mold closing time varies considerably with preform temperature; hence, control is important.

Gate Sizes

In our contacts with the engineering departments and the die designers in our customers' plants, we are very often asked to recommend gate sizes for plunger molded parts. In the past, the actual dimension of the gate has been determined largely by trial and error and there had been very little written on over-all dimensions.

The design chart in *Figure 10* was developed after careful examination and measurement of many plunger molded parts produced of general purpose phenolic materials. The actual area of the gates so measured fell generally along the sloping line of the chart. This chart may be used as a starting point for determining the gate size according to the net weight of the molded part.

It is recognized that the actual area of the gate of any individual molded part is dependent upon the following conditions:

1. Geometry of the molded part.
2. Location of gate.
3. Plunger pressure available in particular press and mold according to number of cavities.
4. Optimum mold temperature.
5. Plasticity and heat sensitivity of particular material to be used.

These data should apply to the majority of plunger molded parts, which normally weigh less than 200 grams.

However, when a die is designed, it is necessary to recommend a minimum gate area. If non-filling is encountered when the new die is first tried, it is usually necessary to adjust the individual gates. This is done by enlarging the gates for each cavity where the non-filling is encountered.

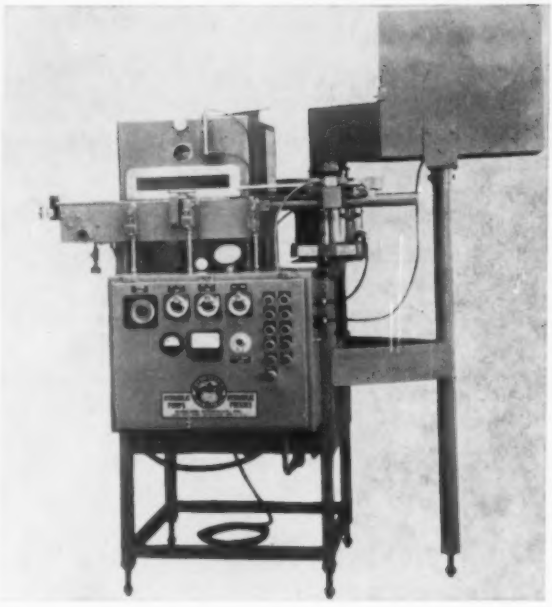

Figure 6. Rodgers Hydraulic Inc. automatic radio frequency preheat feed unit for Rodgers press as shown in Figure 5

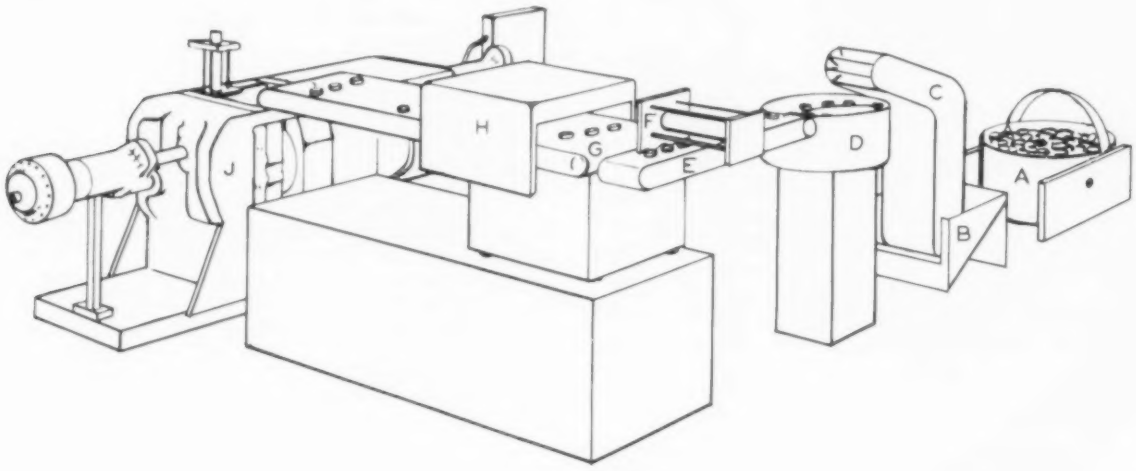

Figure 7. Typical dielectric preheating arrangement for automatic plunger molding. Lester Model HP-2½X-T

UNIT	FURNISHED BY
A. Preform Barrel	Customer
B. Preform Hopper	Customer
C. Preform Elevator	Customer
D. Syntron Vibrator	W. T. LaRose & Associates, Inc.
E. Conveyor	W. T. LaRose & Associates, Inc.
F. Wiper	W. T. LaRose & Associates, Inc.
G. Preheater Belt	W. T. LaRose & Associates, Inc.
H. Dielectric Preheater	W. T. LaRose & Associates, Inc.
J. Automatic Transfer Molding Machine	Lester-Phoenix, Inc.

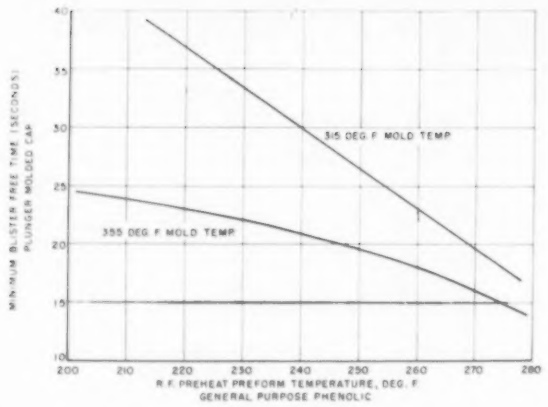
MINIMUM BLISTER FREE TIME (SECONDS) PLUNGER MOLDED CAP
315 DEG. F. MOLD TEMP.
355 DEG. F. MOLD TEMP.
R.F. PREHEAT PREFORM TEMPERATURE, DEG. F.
GENERAL PURPOSE PHENOLIC

Figure 8. Effect of preform temperature on minimum blister free molding time

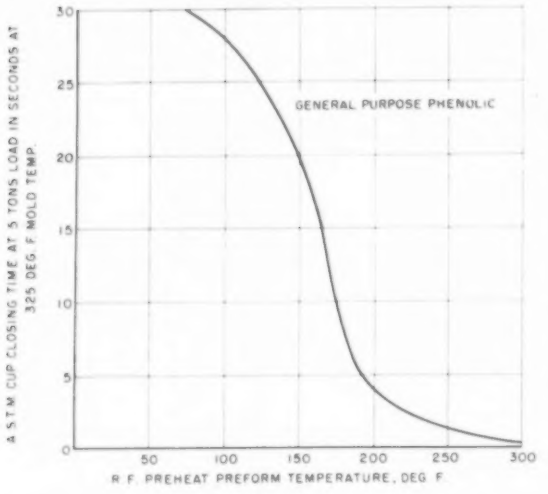
A.S.T.M. CUP CLOSING TIME AT 5 TONS LOAD IN SECONDS AT 325 DEG. F MOLD TEMP.
GENERAL PURPOSE PHENOLIC
R.F. PREHEAT PREFORM TEMPERATURE, DEG. F.

Figure 9. Preform temperature and softness determine mold closing time

Determination of Specific Gravity

An easy and practical method for determining the specific gravity of phenolic molded parts is the Flotation Method. The procedure is as follows:

1. Weigh out correct amount of calcium chloride ($CaCl_2$).
2. Fill a one gallon wide mouth jug half full (2 quarts) with distilled water.
3. Immerse jug in cold water bath (40-50°F.).
4. Pour in $CaCl_2$ slowly and stir continually. Caution—solution will heat up due to chemical reaction; keep below 150°F. to prevent breaking of jar or splash burns.
5. When all $CaCl_2$ added, fill jug with water to the 1 gallon mark and allow to cool to 23°C ± 2°.
6. Immerse the molded parts; agitate to remove all air bubbles.
7. Remove molded parts, wash in tap water, and dry.

Figure 11 shows the proper amounts of $CaCl_2$ for various specific gravity values. Example: A certain part molded of BMC 5000 Black 25 should have a minimum specific gravity of 1.33. A solution is made by mixing 3.8 pounds of $CaCl_2$ in a gallon of H_2O. The molded part is immersed in the solution. If the part floats, this indicates that it is below the minimum specific gravity required. This is probably due to the molded part being porous or blistered. If the part remains in suspension, it is almost exactly at the minimum specific gravity required. If the part sinks, then it has a greater specific gravity than the minimum requirement. This is indicative of a good, sound molded part.

Preform Dimensions

Another factor which is very important in the technique of plunger molding is the diameter of the preform and the height of the total charge of preforms going into the plunger well.

At right is a plunger pressure and preform ratio chart prepared by D. M. Buchanan of Union Carbide Plastics Co. and is helpful in determining the diameter of the preform and pressure chamber depth required for general purpose phenolic materials. The specific figures used are based on phenolic cellulose filled materials having a molded specific gravity of 1.40 and a preform density of 18.5 grams per cubic inch. However, before going any further into detail, it might be wise to first review the fundamental requirements, page 468:

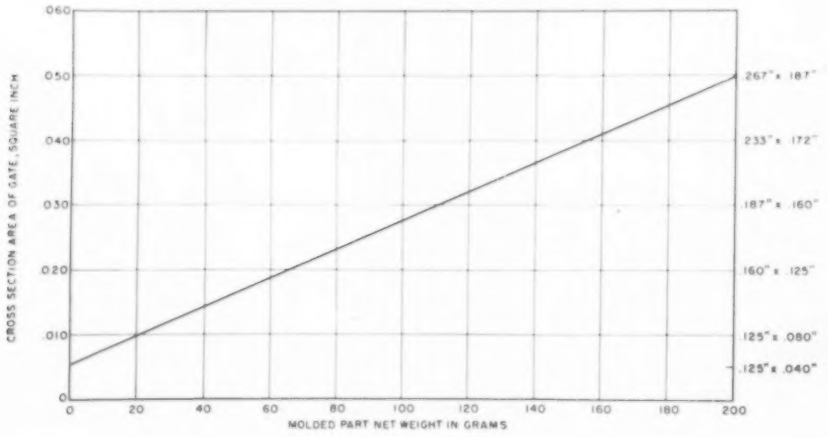

Figure 10. Design chart gives gate size and area needed for net weight of part

PLUNGER MOLD PRESSURE AND PREFORM RATIO CHART

A	B	C	Plunger Pressures in Tons		Preform Size & Weight (1)			
Plunger	Diam. (inches)	In.² Area	D For 8000 #/in.²	E For 12,000 #/in.²	F Max. (2) Diam.	G Max. Hgt. (3)	H Cu. In. (4)	I Wgt. (5) Grams
1-1/2	1.500	1.767	7.1	10.6	1.312	3.43	4.62	86
1-9/16	1.562	1.918	7.7	11.5	1.375	3.50	5.20	96
1-5/8	1.625	2.074	8.3	12.4	1.500	3.75	6.64	123
1-11/16	1.687	2.246	9.0	13.5	1.500	3.75	6.64	123
1-3/4	1.750	2.405	9.6	14.5	1.562	3.93	7.52	140
1-13/16	1.812	2.580	10.3	15.5	1.625	4.06	8.42	156
1-7/8	1.875	2.761	11.0	16.5	1.687	4.25	9.60	178
1-15/16	1.937	2.948	11.8	17.6	1.750	4.37	10.50	194
2	2.000	3.141	12.6	19.0	1.812	4.50	11.60	214
2-1/16	2.062	3.341	13.3	20.0	1.875	4.68	12.90	238
2-1/8	2.125	3.546	14.2	21.2	1.937	4.87	14.37	266
2-3/16	2.187	3.758	15.0	22.6	1.937	4.93	14.50	268
2-1/4	2.250	3.976	16.0	24.0	2.00	5.00	15.70	290
2-5/16	2.312	4.200	16.7	25.2	2.062	5.15	17.3	320
2-3/8	2.375	4.430	17.7	26.6	2.125	5.30	18.8	350
2-7/16	2.437	4.666	18.7	28.0	2.187	5.50	20.6	380
2-1/2	2.500	4.908	19.7	29.6	2.250	5.62	22.3	412
2-9/16	2.562	5.157	20.6	31.0	2.250	5.62	22.3	412
2-5/8	2.625	5.412	21.6	32.5	2.375	5.87	26.0	480
2-11/16	2.687	5.673	22.7	34.0	2.437	6.12	28.5	527
2-3/4	2.750	5.940	23.8	35.7	2.500	6.25	30.6	566
2-13/16	2.812	6.213	25.0	37.3	2.500	6.25	30.6	566
2-7/8	2.875	6.492	26.0	39.0	2.625	6.56	35.5	656
2-15/16	2.937	6.777	27.0	40.6	2.625	6.56	35.5	656
3	3.000	7.068	28.2	42.4	2.750	6.87	40.8	755
3-1/4	3.250	8.296	33.2	50.0	2.937	7.31	49.5	915
3-1/2	3.500	9.621	38.5	58.0	3.125	7.75	59.5	1100
3-3/4	3.750	11.045	44.4	66.5	3.375	8.31	71.4	1320
4	4.000	12.566	50.3	75.5	3.625	9.06	93.7	1735
4-1/4	4.250	14.186	57.0	85.0	3.875	9.62	114.5	2120
4-1/2	4.500	15.904	63.6	95.5	4.000	10.00	125.6	2320
4-3/4	4.750	17.721	71.0	106.5	4.250	10.62	150.0	2780
5	5.00	19.635	78.5	117.5	4.500	11.25	178.0	3300

(1) For phenolic cellulose filled materials having a Molded Specific Gravity of 1.40 and a Preform Density of 18.5 grams per cubic inch.

(2) Maximum diameter of preforms is 10% less than plunger well diameter in 1/16 inch increments.

(3) Maximum height of mold charge, (stacked preforms) 2½ times the preform diameter.

(4) Total cubic inch volume of mold charge.

(5) Total gram weight of charge (18.5 grams/cubic inch times volume).

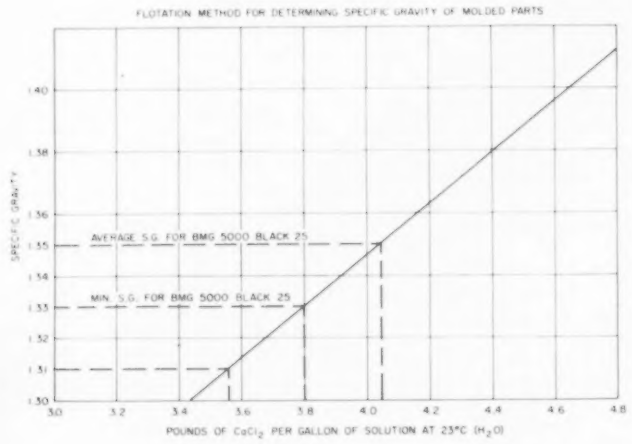

Figure 11. Chart for makeup of immersion solutions for measuring specific gravity of molded phenolic parts

Factors Affecting Dimensions of Molded Phenolic Parts

Molding Conditions

Compression Pressure —Higher pressures reduce shrinkage. This is tied in with plasticity.

Plunger Pressure —Higher pressures reduce shrinkage but if mold flashes, the shrinkage increases substantially.

Temperatures —Higher mold temperatures, above 335°F. increase molding shrinkage.
Higher preform temperatures reduce shrinkage due to liberation of moisture during preheat and more complete cure of molded parts.

Mold Cure —Longer cures reduce shrinkage because of lower coefficient of thermal expansion.

Gate Size —Plunger Molding
Larger gate permits more internal pressure in cavities, hence lower shrinkage of molded parts.

Preheating Techniques

Preform hardness —Affects preheat temperature and uniformity. Use rectangular preforms, heat on side.

Electrodes —Use of insulating plate under preforms and air gap above.

—Voltage control on power lines to preheaters to maintain uniform preheat.

Plasticity of Materials
Stiffer materials molded at higher pressures results in lower shrinkage due to higher molded density from greater back pressure.

Use of Shrink Blocks
May control warpage but will not overcome after-shrinkage.

- *Sufficient space should be provided between the upper half of the mold and the head of the press in order that the preheated preforms may be easily and quickly loaded into the pressure chamber.*
- *The diameter of the preforms should be at least 10 per cent less than the inside diameter of the pressure chamber to allow for swelling of the preform during the preheating operation. For rapid loading, the preform must drop freely into the pressure chamber.*
- *The total height of the preform charge should not be more than 2½ times the preform diameter (see chart, columns F and G).*
- *The mold charge should be sufficiently large so that the cull of material left at the bottom of the pressure chamber is not less than 1/16 in. thick. Lesser quantities are very apt to produce parts of low density due to a lack of positive pressure on the material entering the cavities at the end of the stroke.*
- *It is important that the plunger enter the pressure chamber at least ⅜ in. before coming in contact with the mold charge of material. If this precaution is not taken, the softened material will, in all probability, flash out of the pressure chamber when struck by the fast moving plunger. The amount of flashing will depend on the clearance between the plunger and the chamber wall. This loss of material will result in porous or low density molded parts.*

The usefulness of this chart is demonstrated by the following examples: **Example A:** *What size preforms and pressure chamber should be used for a mold charge of ½ pound or 227 grams?*

Read down Column I to 214 grams (the nearest value to 227 grams) then across to the left. In Column H the volume of the preform charge is given as 11.60 cu. in. The maximum height of the charge is set forth in Column G as being 4.50 in. This indicates that a pressure chamber depth of 5 in. should be adequate. In Column F, the maximum diameter of the preform is given as 1.812 in. A 12.6 ton capacity top ram should be used for a plunger pressure of 8,000 lb. per sq. in. The diameter of the plunger is found in Column A as being 2 in. Example B: The chart may also be used to determine the maximum mold charge possible for a given set of conditions such as those used in Example A under Molding Pressures.

Given—

Plunger diameter 3 inches
Number of cavities—8

From the chart—

Preform diameter (max.)—2.75 in.
Height of mold charge—6.87 in.
Volume of preform charge—40.8 cu. in.
Total weight of charge—755 grams. max.

Allowing 10 per cent for cull and runners, this leaves (755-75) 690 grams for the eight cavities or 680 divided by 8 = 85 grams for the maximum possible weight of each molded piece.

In the course of this presentation, some of the latest data and developments in phenolic molding techniques have been discussed. The increased use of automatic molding methods as a means of reducing production costs has brought about new problems and the solutions to them. It has been shown that uniformity of preform hardness is essential for good R.F. preheat characteristics and, in turn, uniformity of preform temperature makes possible increased production rates by reducing mold closing time and cure time. In addition, the fundamental rules for determining gate sizes were discussed. Finally, the table presented demonstrates its effectiveness as a reference for rapid calculation of plunger mold pressure and preform ratios.

Literature References

1. Guzzetti, A. J., "Shrinkage of Thermosets" (February 1957) Development Department, Union Carbide Plastics Company, Division of Union Carbide Corporation, Bound Brook, New Jersey.
2. Vaill, E. W., *SPE Journal*, *16*, 413 (1960).

Writing Meaningful Specifications For Plastic Parts

Want to write good specifications for molded parts? This article will show you how by selecting the proper raw materials, proper designing of the part, and establishing performance tests for the molded parts

Henry S. Byrne,
R. L. Miller
and
Robert N. Peterson

E. I. du Pont de Nemours & Co., Inc.
Polychemicals Department

Any use for a plastic, or a metal, starts out as an idea in someone's mind. From this point it develops into a production item. The transition is accomplished in a series of very logical engineering steps, and the quality of the final production item becomes a matter of specifications. This article is therefore directed toward the writing of meaningful specifications.

New plastic materials are constantly being developed. Further, the price trend for plastic materials is downward as production volume increases, while the price of most metals is on the increase. Injection molding adds further advantage in producing large numbers of parts.

Varieties of present uses are interesting. *Figure 1* shows a few of the newer ones. Each use followed the same stepwise pattern through material selection, design, prototype testing, redesign, retest, production, and quality control.

Let's now take a typical, although hypothetical, part (which happens to be a business machine part) shown in *Figure 2*. Assume that it has been developed through the stepwise procedure, and consider the development of a meaningful specification.

Any good specification should contain three basic portions: 1. the raw material, 2. the design of the part and 3. the performance of the part in use.

Raw Material

The raw material for any part is selected for its physical properties, with due regard for economic and engineering requirements.

Identification of Raw Material—This should include trademarks, manufacturer's name, identification numbers and color, all of which provide positive identification for the raw material. The section may include reference to standard A.S.T.M. or military procurement specifications, for instance.

The use of reworked material, (i.e., sprues and runners), may reduce part cost without impairing quality; however, the percentage allowable depends on the factors controlling the quality of the desired part. Such percentages must be determined and specified.

In general, processors should be permitted to rework runners, sprues and parts that do not show contamination or discoloration.

Quality—This can be covered by a chemical analysis of the basic polymer to determine that the material is indeed "Zytel" 101. A.S.T.M. tests, such as viscosity or tensile strength, may be used to check uniformity of material.

For the most part, resin quality and uniformity are the responsibility of the resin supplier. Quality of rework, obviously, is the responsibility of the processor.

Our typical business machine part may be specified as follows:

> **Material:** Du Pont "Zytel" 101 nylon resin (NC-10) or equivalent (as under A.S.T.M. Specification D789-59T, Type 1 or MIL-17091B, Type 1)

Design Specifications

The second major portion of the specification involves the design of the part. The design specification includes tolerances, voids, surface finish, parting lines, flash, gate location, and warpage. How these are specified affects the mold design and the method of fabrication.

Dimensional Tolerance—The dimensional tolerances should be as close as required for functioning. As tolerances become tighter than this, the cost of both tooling and molding rises very rapidly. Such tight dimensional tolerances require very close control of the processing variables and necessitate extra inspection, which contributes to a high unit cost.

Design drawings must also define the conditions under which the dimensions must be held. Parts should not be measured immediately after molding; they should be allowed to reach equilibrium under the stated environment. Drawings should state that dimensions shall be measured not less than "X" hours after molding, or after annealing and moisture conditioning.

Other important considerations are:

1. Over-all tolerances in the title block in "inches per inch", not as a fixed value.
2. Critical dimensions should be identified with specific tolerances; let over-all tolerances control less important dimensions.
3. If parts are to be machined after molding, allow generous tolerances in these areas.

Specifications might be as follows: **Dimensions to be measured "X" hours after molding. Tolerances, unless otherwise specified are 0.015 in. per in. on all decimal dimensions.**

Dimensional tolerances are affected by several production and tooling variables such as the number and size of cavities and the degree of control of the molding operation. As the number of cavities in a mold is increased, tight dimensional tolerance becomes more difficult. Thus, some relaxation in tolerances must be allowed if a multiple cavity mold is desired.

Voids—The presence of voids does not necessarily mean that the part is defective. Most thermoplastics, on cooling, tend to form bubbles or voids in thick sections. The only real reason for rejection of parts with voids is failure to which the void has contributed.

Sections of parts that must be void-free should be clearly indicated. The unnecessary specification that parts must be entirely void-free can increase the cost of a part.

On the cam and gear assembly of *Figure 2*, our specification should read "gear teeth and rim must be free of voids". Such voids would reduce the fatigue endurance limit of the part.

Surface Finish—The type and degree of surface finish required should be clearly indicated. If a highly polished finish is necessary, it should be specified. On other surfaces, finish need not be covered except in general terms which allow for ease of molding.

Surfaces which must be clear of imperfections such as tool marks, sinks, blisters and flow lines, should be clearly indicated. If such surfaces are to be painted or vacuum metallized, a high polish is usually required. (Even small imperfections are highlighted by these finishing techniques). A specification for the gear and cam finish follows: **Surface of bearings and cams to be RMS of 32 or better. No sinks, pits or splay on these surfaces. Other surfaces sufficient for easy ejection.**

Parting Line—The location of a parting line of a mold may be influenced by flash, part appearance and structural design. In such cases, parting line location should be specified on the drawings. Experienced processors can assist in altering part design to simplify tooling or molding.

The parting line in our gear-cam part could be located in several places. One end of the gear simplifies the tooling requirement.

Flash—Where flash is undesirable, the drawing should so indicate. The length of allowable flash may be given in a measurable dimension. (Special procedures for avoiding or removing flash add to the cost of a part). A specification for flash on the gear-cam part is: **"Flash is not to exceed 0.005 inch."**

Gating—The gate should be located where it will cause the least difficulty.

The specification on gating should define areas to avoid such as cam or bearing surfaces. To permit maximum concentricity in the typical part, the gate should be located as shown in *Figure 3*.

Warpage—The allowable warpage of parts after molding should be specified, even though all dimensions may be met. When minimum warpage is desired, the cooling of parts in a jig or fixture may be necessary. It should be remembered that *post* molding operations (annealing, moisture conditioning, etc.) may cause warpage.

Minimum warpage depends upon a proper balance of several factors. These include uniform part thickness, location of knock-out pins, and optimum molding conditions.

The specification for the hypothetical business machine part in *Figure 2* is TIR $< .002''$ referred to center line.

Performance Specifications

The third major portion of a suggested specification concerns the quality of the molded plastic part. Earlier work on design, material selection and end-use testing has given assurance of part performance. From here on, it depends upon the molder and his techniques for providing quality moldings. Performance specifications should include the fewest tests to assure desired field performance. Statistical quality control techniques should be used to control sampling. Performance specifications are concerned with two factors; the first is visual inspection; and the second is simulated service tests. Any correlation found between visual inspection and simulated service test allows for a reduction in the number of the tests.

Visual Tests—This kind of test is concerned with color, splay, weld lines, sinks, etc. The test is established by considering the effect of each of these on the final performance of the part. All of the factors may not be necessary for every part.

Figure 1. Some plastics parts used in business machines

For example, color may not be of paramount importance. Color matches, while desirable, can often contribute a great deal to cost of the part and little or nothing to the function. On the other hand, color as a measure of quality of molded part can seriously affect performance. The end user should submit samples showing the permissible variations in color, or any of the other visual defects.

An example of a visual inspection that was correlated with product performance concerned the breakage of a plastic hand mirror frame. The break always occurred at the weld line opposite the gate. Experience showed that the frame would be expected to break if the weld line were visible under controlled inspection. This criterion was written into the inspection performance specification.

Simulated Service Test—The second test for a molded part should simulate the ultimate use for the part.

Care must be taken to use a meaningful test. Excessive speeds, loads, or impacts, well beyond ultimate requirement, can frequently cause rejection of good parts.

A simulated service test on a part like the cam-gear assembly of *Figure 2* might consist of impact and/or torque loading.

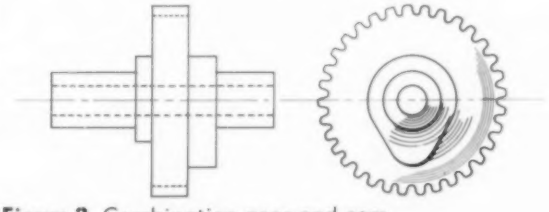

Figure 2. Combination gear and cam

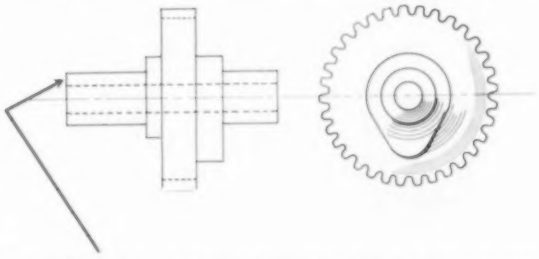

Figure 3. Suggested gate location for maximum concentricity. Gate should avoid cam and bearing surfaces

High Density Polyolefins in Corrosion Engineering

O. E. Larsen, *Phillips Chemical Co.*

Design and product application ideas for polyolefins

For years the corrosion engineer was predominantly concerned with metals. As progress ensued, many alloys were developed which alleviated but complicated his corrosion problems. In recent years, plastics have been added to his list of methods for preventing corrosion. Each new type of plastic has added a completely new approach for combatting corrosion. Without authentic application data supplied by the raw material supplier, it would be nearly impossible for the corrosion engineer to select and properly use these new materials. Polyolefins, for instance, are in a class of new materials which are rapidly taking their place in the field of corrosion prevention. Within this class, there are many types of resins which vary quite widely in properties and recommended applications.

Types of Polyolefin Resins

Polymers and copolymers of ethylene, propylene and other longer chain olefins plus special compounds of each are all classified as polyolefins. Within the polyolefins classification there are several series of resins which differ in physical properties and chemical resistance. Each series of resins consist of types which differ usually by one pertinent parameter.

Table 1 shows a comparison of the pertinent physical characteristics of typical types within a series of low, medium and high density polyethylenes and a ethylene-butene copolymer. Emphasis is placed on the higher density resins as they are the materials found to be most suitable for industrial application. Density and melt index (function of viscosity and molecular weight) are the basic parameters used to describe these resins. Part strength, rigidity, and chemical resistance increases with increase in density. Brittleness temperature, Izod impact values, and resistance to stress cracking are improved as the Melt Index is decreased (increase in molecular weight). As can be noted, the ethylene-butene copolymer exhibits greatly increased resistance to environmental stress cracking. The higher melt index resin types or easier flowing resins are used for injection molded items, paper coating, and for clear film. The lower melt index resin types are for extruded items such as pipe, tubing, sheet, and blown bottles. Coating powders are usually of high melt index resin types so that smooth coatings can be obtained.

In industry and as a tool for the corrosion engineer, a chemically resistant plastic is needed which is tough, rigid (but not brittle) and is low in cost. In most cases, the high density polyolefins meet these requirements. However, it is necessary to select the specific resin type which offers the best balance between resin properties and processing characteristics.

Some Recommended Applications

Field results show that the 0.960 density polyethylenes are most applicable where rigidity, permeation resistance, chemical resistance, heat resistance and lubricity are of prime importance. The 0.960 density resins can stand only limited tensile stresses for long periods of time. However, these materials are exceptionally tough and will withstand high stresses for short periods of time. Ideal applications for the 0.960 density resins are drainage pipe, low pressure disposal lines, bearings, electrical conduit, instrument housings and miscellaneous injection molded and vacuum formed sections.

The 0.950 density ethylene-butene copolymers are most applicable where superior performance under long term load and resistance to stress cracking are of prime importance. These copolymers are easy to fabricate and they exhibit most of the desirable characteristics of the 0.960 resins, except to a slightly lesser degree. Ideal applications for the 0.950 density copolymers are tanks, pressure piping, and the many hand fabricated applications where chemical resistance and toughness are required. Exceptional performance of these copolymers are obtained in wire coatings, cable jacketing, and in general sheet applications.

The excellent chemical resistance of these polyolefins is illustrated in *Table 2*. These data on the 0.960 density resins were obtained by immersing injection molded tensile bars in the various environments for three months at three different temperature levels, though only the 80°F tests are reported in this article. Weak acids, caustics, salt solutions, and paraffinic hydrocarbons have little effect on these resins. Continued immersion in chlorinated solvents and aromatic hydrocarbons such as perchloroethylene and

Table 1. Physical Properties of Polyethylene and Ethylene-Butene Copolymer

	High Density Copolymer	High Density Polyethylene	Medium Density Polyethylene	Low Density Polyethylene
Density	0.950	0.960	0.933	0.914
Melt Index (ASTM D 1238-57T)	0.3	0.2	2.8	7.8
Tensile Strength (ASTM D 638-58T), p.s.i.	3,600	4,400	2,000	1,450
Elongation (ASTM D 638-58T), %	70	30	500	550
Stiffness (ASTM D 747-58T), p.s.i.	115,000	150,000	37,000	8,500
Vicat Softening Temperature (ASTM D 1525-58T), °F	255	260	—	—
Hardness, Shore D	67	68	55	44
Izod Impact Strength ft.-lb./in. of notch	4	14	>16	>16
Environmental Stress Cracking, F50, hr.	400	60	2	2
Brittleness Temperature (ASTM D 746-57T), °F.	<−180	<−180	<−76	<−76
Shape Retention at Sterilization Temperature (250°F.)	Yes	Yes	No	No

toluene will cause swelling. However, on removal of parts from these solvents, the resins regain their original properties. Strong oxidizing acids at elevated temperatures will rapidly attack these materials.

Since most industrial applications are usually of a severe environment, it is a general recommendation that protective ingredients be incorporated in the resins to protect them from oxidative degradation. Oxidative degradation of polyolefins as with other high polymers is accelerated by thermal treatment and exposure to ultraviolet light. For this reason, both thermal and U.V. stabilizers should be incorporated in the resins. Fine particle size carbon black offers the best protection to ultraviolet light and appears to augment the effectiveness of the antioxidants. For these reasons, pipe, conduit, and industrial sheet compounds should contain thermal antioxidants and carbon black. Sheet materials, particularly, should contain an antioxidant to provide protection during fabrication where welding and forming operations are used.

Pipe Applications

There are many potential applications for merchant and engineered pipe throughout industry. Gas gathering lines, gas distribution lines, salt water disposal lines, and potable water transportation systems are just a few.

Pipe fabricated from a compounded low melt index ethylene-butene copolymer resin surpasses the 1000 hour stress life test required by the forthcoming Department of Commerce standard on polyethylene pipe. This pipe resin has a 1000 hour stress at rupture in water of 1800 psi

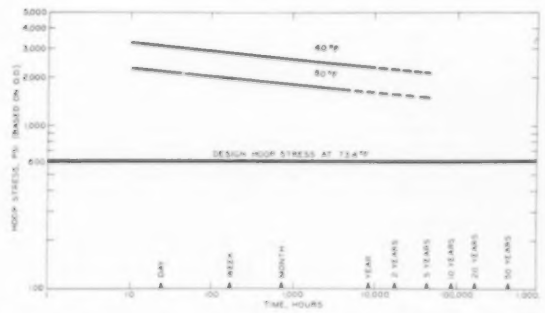

Figure 1. Stress rupture life data for high density polyolefin pipe

Figure 2. Light weight 6" high density polyethylene pipe is easily handled without the need for expensive hoisting equipment

Table 2. Ultimate Tensile Strength and Elongation of 0.960 Density Phillips Chemical Co. Polyethylene After Three Months Storage—80°F

Chemical	Percent Change In Tensile Strength	Elongation
Battery acid (36%)	−2.6	−4.3
Nitric acid (70%)	+1.5	−13.0
Hydrofluoric acid (52-55%)	−3.1	+13.0
Phosphoric acid (85%)	−0.37	+0.0
Chromic acid (25%)	+0.15	+0.0
Hydrochloric acid (37%)	−0.43	−4.3
Glacial acetic acid	−0.43	+13.0
NaOH (50%)	−0.28	+4.3
Nitrobenzene	−3.85	+30.4
Phenol	−0.15	+4.3
10 wt. motor oil	−3.5	+21.7
Hydrogen peroxide (30%)	−3.4	+8.7
Clorox	−1.0	+8.7
Methyl Salicylate	−7.3	+39.1
Ethylene glycol	−1.8	−4.3
Tetralin	−12.7	+82.6
Benzaldehyde	−7.0	+17.4
Acetophenone	−8.7	+43.5
Chlorobenzene	−6.9	+34.8
Butyl carbitol	−4.6	+17.4
Toluene	−11.8	+56.5
Mineral Oil	−2.0	+26.0
Aniline	−1.7	+4.3
Xylene	−13.3	+113.0
Diethylene triamine	−3.5	−4.3
5% soap solution	−3.0	+30.4
Water	−1.5	+8.7
Air	−0.28	+0.0
Ethyl alcohol	−0.43	+17.4
Amyl acetate	−10.6	+104.3
Diethyl ether	−8.8	+113.0
Turpentine	−13.6	+152.2
Tetrachloroethane	−10.7	+74.0
N-Heptane	−10.8	+95.7
Cyclohexane	−14.3	+95.7
Ethyl acetate	−7.4	+95.7
Carbon tetrachloride	−11.5	+47.8
Benzene	−6.5	+4.3
Bromine water	−1.6	+4.3
NH_4OH (28%)	+0.87	+0.0

@ 80°F. *Figure 1* illustrates the relationship between the ultimate stress life of this pipe compared to recommended design stress. As shown, a 3 to 1 safety factor exists at 1000 hrs. and a 2.75 to 1 safety factor is indicated for a 10 year service life at 80°F.

High density polyolefin pipe installations result in low initial costs. Much of the savings result in the ease by which the pipe can be handled. The pipe is light in weight. *Figure 2* shows how one man can lift a 20 foot joint of schedule 40 six-inch pipe which weighs only 46 pounds. The pipe is easily joined by the butt-fusion method. *Figure 3* shows how two men can easily lay a mile a day of 6 inch pipe using a portable joining apparatus. Many types of fittings and couplings are available which are suitable for joining the pipe sections.

A typical example of how this pipe can be used to combat the corrosion problem on an existing installation is shown in *Figure 4*. In this installation, 4 inch polyolefin pipe is being pushed inside a corroded 6 inch steel line. The 4 inch pipe was joined using the fusion method which eliminates bulky couplings. Slightly more than 1500 feet of 4 inch pipe in a continuous length was pushed through the corroded 6 inch steel line.

Because high density polyolefin pipe is a non-conductor of electricity, its use as corrosion resistant electrical conduit allows many advantages. As with pipe, lower installation costs result. The lubricity of the pipe and its availability in coils allow longer conduit runs as less resistance to pulling of wires is encountered.

Sheet Applications

Polyolefin sheet materials have many industrial applications, particularly where corrosion is a problem. Aside from the obvious advantages of economics and chemical resistance, its slippery surface aids in handling dry chemicals. An excellent example of this is a lined railroad hopper car used for transporting carbon black.

Figure 5 shows an interior view of one of the hoppers which is lined with 30 mil 0.950 density ethylene-butene copolymer sheet. The primary purpose of the lining was to prevent contamination of the carbon black with rust. However, the slick surface of the lining aided in unloading the car. In an unlined car, 200 to 300 pounds and sometimes up to 1500 pounds of carbon black can be left in the car after it has been dumped. The copolymer liner allowed the car to empty clean and considerably reduced the unloading time.

Figure 3. More than a mile a day of 6" high density polyethylene pipe can be laid by 2 men

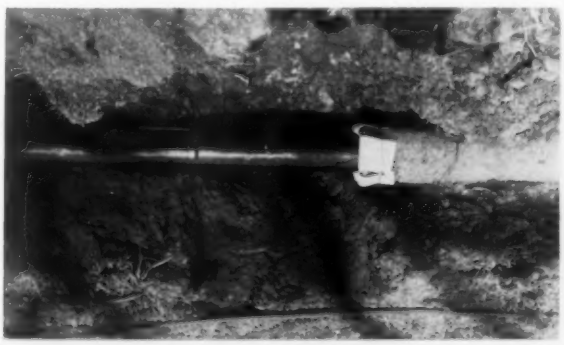

Figure 4. Money was saved by pushing over 1,500 feet of 4" high density polyethylene pipe through corroded 6" steel pipe to replace a gas main

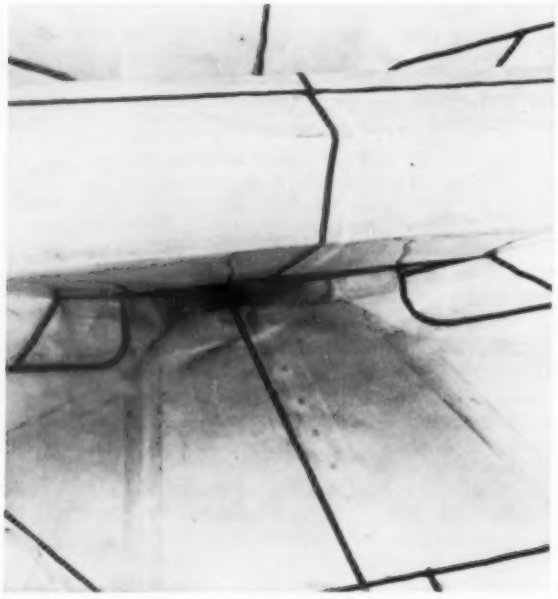

Figure 5. Hopper car liner

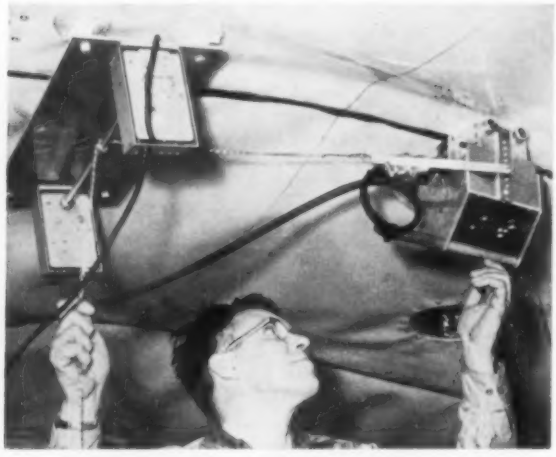

Figure 6. Automatic strip feeder

The liner was installed by mechanically attaching pre-cut copolymer sheet to the metal sidewalls of the hopper. This was accomplished by fastening two edges of the pre-cut sheets to rivet like "Nelson Studs" electrically welded to the hopper. The sheet was pressed over the studs, covered with a washer and secured by use of a rivet set. The adjacent pre-cut sheets were lap-welded with strip to the fastened sheet so that the rivets and washers were covered. By this method the lining was unbonded except each sheet was held to the hopper by the "Nelson Studs" and the strip-welds around its edges.

The strip welds were made by hand, by hand operated strip feeders, and by an automatic welding apparatus. The purpose of the strip feeder was to hold the hot gas nozzle at a constant angle and distance from the welding strip. In this way, high strength welds at fast rates were obtained. The feeders also allowed maintenance of constant pressure on the strip. *Figure 6* shows a long seam being welded along the roof of the hopper using the automatic strip feeder. The feeder was held to the roof of the car by magnets. By use of a winch, welding speeds up to 16 inches per minute were obtained.

There are numerous other applications for sheet. Some of them are protective coverings for concrete supports, material transfer chutes, fabricated tanks, wall coverings, and equipment parts.

Special Applications

Corrosion protection in industrial plants is not limited to tanks, piping, conduit and their related structures. In many of these plants the existence of metal is costly whether it be in the office, shop, or the laboratory. Waste paper baskets, soap dispensers, conveying equipment, and tote boxes are just a few of the many other types of applications. Plastics can, in most cases, improve their utility, life, and appearance.

Conveyor belt rollers are a typical example of an improved application made possible with the use of polyolefin type resins. *Figure 7* shows a conveyor belt installation where the use of high density polyethylene rollers has increased wear life four to six times over the previously used conventional steel rollers. It is used to transport ammonium sulfate which is highly corrosive. Aside from the increased service life a considerable reduction in maintenance costs is allowed because lubrication is not required. The rollers were fabricated from high density polyethylene pipe supported by bearings of the same material. They were supported on stainless steel shafts. The installation exemplifies the lubricity, toughness, and strength characteristics of these resins.

The use of high density polyolefins for pipe wrap tape, wire and cable coverings, rope, and filter screens, and cooling tower components is also gaining wide acceptance in industry.

This article was adapted from a paper presented at the Golden Gate Regional Technical Conference, October 5, 1960.

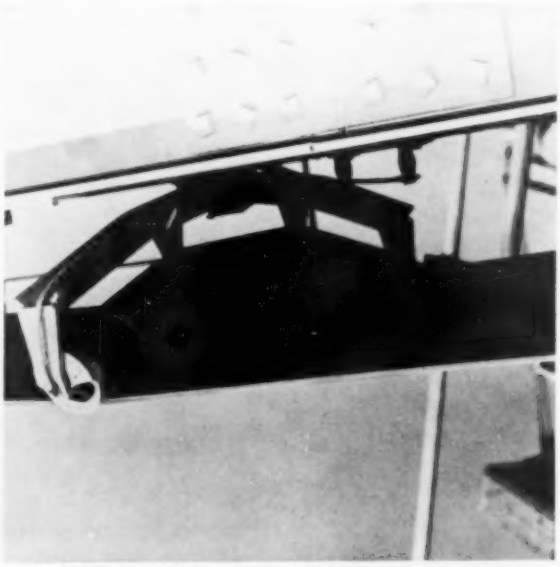

Figure 7. High density polyethylene conveyor belt rollers

Important Considerations

Automatic Injection Molding

John K. Neely, *P.Eng., Plastics Section, Technical Service and Development Dept., Dow Chemical Company of Canada, Ltd.*

Factors to think about before automating your injection molding operation—

- *Do you have volume production?*
- *Ejection of parts and runners must be positive*
- *A safety factor must be applied*
- *High-speed automatic equipment costs more*
- *Considered bulk-handling techniques*

Automatic molding involves the manufacture of molded parts completely degated and ready for packaging or routing to a sub-assembly or finishing operation without the need for operating labor. In a more complete sense it will also include provision for automatic handling of the feed stock and automatic conveying of the finished parts away from the molding machine.

Economic Considerations

The factor most important in trying to decide whether or not to automate is—economics. A detailed economic study is a "must" and there is no magic formula to be consulted for the answer. As a general rule, look for long run jobs which will easily amortize the costly tooling in a short period of time. The economic factors which will govern the final decision will not be the same in every case but some of the more usual ones would be as follows:

Reduction in Direct Labor Costs—Sometimes this is the only incentive. A careful analysis of the manual vs the automatic system must be made and an estimate made of the total gross annual cost of the employees which would be displaced remembering that some skilled labor will still be required to set-up and maintain the automatic equipment. This figure is then compared with the cost of amortizing the needed equipment.

Savings in Material Costs—Very real savings can be brought about through closer control of piece weights and less scrap generated through faulty molding material handling practice.

Automatic molding will make more rigid demands of your equipment and this will strongly influence the costs to be encountered. Some of the factors to consider are these:

- Tooling must have more than ordinary planning time and better than ordinary material and workmanship. Ejection of parts and runners must be positive which will add to the expected complication. This will certainly make the tooling more expensive but the extra initial expense will pay handsome dividends in the form of trouble-free operation and quality parts.

- A safety factor must be applied to machine capacity ratings to keep actual throughput well within the machines rated capabilities. The usual trend in industry is to up-rate machine capacities through automation. However, many molding shops are already running their machines at over capacity rates simply because the operator has developed the skill to anticipate and correct the troubles which are generated by this practice. It would be unrealistic to design this type of control into the automatic system so that the only alternative is to throttle back on throughput. Remember that in terms of long run production of satisfactory, quality parts, the slower but steadier automatic system will generally out produce the faster but more erratic manually controlled machine.

- Molding machines specifically designed for high speed automatic operation will cost more than standard semi-automatic machines. Also, a careful survey of the requirements for auxiliary equipment is more essential and the related costs will usually be higher.

Overall Design Factors

Once it has been decided that an economic incentive exists, there are several basic design philosophies which must be recognized and followed when designing an automated factory.

Integrate as much as possible—Make the system as free as possible from the need for operator attention. Consideration should be given to automatic handling of the feedstock as well as removal of the finished parts. Wherever possible, streamline the system to eliminate elements which aren't really necessary in an automated plant but which tend to remain simply through custom and habit.

Separate from the Custom Molding Section—A truly efficient automatic set-up should be completely separated from the custom molding department. The operating philosophy of these two types of operation simply do not mix and once set up and running smoothly the automatic line must be guarded against outside interference no matter how well intentioned it may be.

Allow for By-Passing Operations—Design the system so that if one stage breaks down it can be bypassed without curtailing production of the whole line. This may involve inventorying parts that are only partly finished and

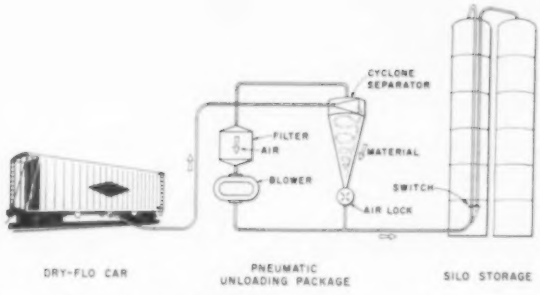

Figure 1. A typical car unloading system

feeding them back-in later after repairs are completed. This may not always be possible but in analysing a proposed system it should certainly be kept foremost in mind.

Provide Adequate Machine Intelligence—Instrumentation is the heart of the system and it would be questionable to skimp here. A thorough understanding of the intelligence required to be built into the system will be needed to make sure that the correct instrumentation is chosen. Remember that control instrumentation is expensive but if chosen carefully, it will more than repay its cost in trouble-free operation.

Follow Good Maintenance Habits—Preventative maintenance must be practiced. Make sure the machinery can be routinely lubricated and cleaned without shutting down. A comprehensive spare parts inventory will be necessary to minimize downtime. Also, the equipment should be designed and laid out so that parts that wear out frequently can be easily changed.

Inspection—Although automatic inspection is used in many industrial processes, visual inspection is probably the best overall method for injection molding. Usually final inspection is good enough but provision should be made for an intermediate inspection stage in the equipment layout.

Raw Material Handling

Long, steady production runs using one type of material and perhaps even one color will merit the serious consideration of current bulk handling techniques. This type of handling has not been developed in Canada as yet but surely must come when production volume so warrants. A volume use of 100,000 lbs./month of any one material is considered to be an approximate minimum quantity which justifies the expense of a bulk handling system in the molding plant.

Besides the obvious elimination of most of the labor costs involved in moving materials in the molding plant, listed below are other important considerations:

Spillage loss is significantly reduced—Surprisingly, ½ to 1% of total raw materials used in most molding plants is lost forever to the manufacturer through spillage at the machine, broken bags or incompletely emptied bags.

Contamination is reduced—Properly designed bulk handling systems are quite foolproof and present U.S. experience has shown the possibility of contamination of a large amount of expensive material to be quite remote. In fact, the reject rate of fabricated parts will be reduced due to the elimination of paper fibers, dust and other foreign material.

Warehouse capacity is increased—Bulk storage facilities can be located outside of existing buildings thereby releasing floor space for production use or for storage of finished products.

Raw material costs are reduced—In the United States, cost reductions in the range of 1¢ per pound have been made possible by efficient bulk handling methods at the resin supplier's plant, plus savings in shipping costs.

Bulk handling methods developed in the United States started with non-returnable 1000 pound containers and have worked up to increasingly larger containers. Actual economies were more questionable in these early stages. The method of shipment which shows the most promise, because of greatest efficiency and cost saving, is by the bulk hopper car. Used for granular materials only, the car is divided into three separate compartments each lined with a durable coating to protect the contents from contamination. The car will hold 130,000 pounds of polystyrene or 115,000 pounds of polyethylene. Elaborate precautions are taken to prevent contamination during shipping.

To unload and store the material, the fabricator must furnish a pneumatic unloading and conveying system. *Figure 1* is a schematic sketch of such a system. Material is sucked out of the bottom connections of the hopper cars into a cyclone separator then blown from the separator into the storage silos. Both phases of this operation are accomplished with a single 30 to 40 h.p. blower and a system of 4-in. diameter tubing. This sizing enables a hopper car to be unloaded within a single shift.

A more expensive but versatile bulk shipping media is the bulk trailer. Railway shipment involves free return of the cars whereas the bulk trailers return expense must be paid by the shipper. Since they are one purpose carriers they must necessarily return empty. One attractive aspect of this method is that pneumatic unloading gear is built in and the trailer can be unloaded by the driver directly into the customer's silo.

Material handling from the silo to the machine hoppers can be handled in a number of ways which will depend on the complexity of the operation and the plant layout. In some simplified cases, the storage silos can be placed on the roof of the plant and a gravity feed system utilized to place material directly into the molding hoppers or perhaps into a dry blender mounted on a scale for direct weighing. One system involves gravity feed to transfer bins or tote boxes which are manually taken to the machines. Where warranted, a secondary pneumatic system can be used to transfer material to the required locations. This can be a simplified system employing flexible tubing or hand operated valves to direct the flow of material or completely equipped with remote controlled valves operated from a central instrument panel.

Molding Techniques

Much has been written and published in the literature on the various techniques used to provide completely automatic operation of the molding machine. A brief review of the most promising techniques and their objectives would certainly seem in order. It is pertinent to note that foolproof, high speed, automatic operation of the injection molding machine has been the objective of that segment of the plastics industry concerned with developing large volume plastics applications usually related to the packaging field.

The problem of automatic degating has been solved in many ways. The use of three plate molds to separate the runner system from the parts is complicated by having to provide mechanical devices to clear the runner system from the mold and, going a step further, the need to convey it automatically to a scrap grinder and recycle the scrap. Attempts to eliminate this problem through hot runner techniques have met with varying degrees of success. Ac-

curate control of the material temperature in the sensitive nozzle or gate area of the hot runner is the key to successful start-up and operation. The temperature must be maintained within fairly narrow limits so that neither freezing nor drooling occurs. This control is aided through the use of insulated nozzles and more recently an internally heated nozzle which can be adapted to hot runner work has been put on the market.

High speed injection together with fast cycling of the molding machine platen movements often fit into the automation picture for the same economic reasons which bring molders to consider automation in the first place. This often doubles the power requirements of the machine, and of course, puts tremendous additional strain on the moving parts. Generally, it will be advisable to purchase machinery which has been designed specifically for this type of service rather than try to convert existing slow acting equipment.

Uniformity of the melt temperature becomes particularly important in an automatic set-up. Small variations in temperature may cause short shots or sticking to occur, resulting in costly interruption of the cycle. Automatic voltage regulators can be used to eliminate fluctuations due to variations in the line voltage. The extent of these variations are shown in *Figure* 2. Also heating cylinders should be insulated or at least shielded to minimize the effect of changing ambient conditions. Such a simple thing as a drafty door near the machine can cause upsets in the automatic cycle. More sensitive heater controls are now available which can immediately sense a change in the controlled variable, including the rate at which the change is occurring, and automatically makes the necessary adjustments. In effect this is what a trained operator does except he cannot measure the rate of change as surely, and as accurately. Although the operator keeps the variable within the control limits, any sudden changes he effects may hamper uniformity.

The increased uniformity of melt temperatures derived from extrusion practice has been effectively demonstrated by screw preplasticizing units so prevalent on the newest European machines. It must be remembered, however, that the screw must have time to do its work and this may rule it out for fast cycling single cavity and small multicavity molds.

Uniformity of plastics melt temperatures is only one of a list of equally important variables which must be under control. Quantity control is imperative for deep draw parts if sticking is to be avoided. Material savings as high as 15% can be realized on large area moldings where too much feed can cause the mold to open slightly. Quantity control can best be accomplished through weigh feeding of the granular feed, positive volumetric feeding of preplasticized material or sensitive timing of a valve mechanism in the feed nozzles or gates of the parts. Certainly the precision available from a good weight feeder is often wasted due to inadequate and sporadic control of the melt temperature in the heating cylinder. The accuracy of the weight of the finished molded part depends on uniform resistance to plastics flow in the heating cylinder as much as it does on accurate weighing of the charge.

Quantity control will have many other benefits besides promoting uninterrupted cycling. Coupled with high speed injection, pressure distribution in the mold will be much more uniform resulting in the reduction or elimination of sink marks, warpage and premature failure due to high residual stress and in improved heat distortion characteristics.

Mold temperature has been shown to have profound effects on the physical properties of items molded at normal injection speeds and for this type of operation it is desirable to circulate warmed, controlled temperature water through the mold to maintain the best physical properties available in the material. As speed of injection has increased, the temperature of the mold surface has been found to have less effect on physical properties but a far more significant effect on reducing the cooling portion of the cycle. Very fast mold filling has permitted the use of surfaces chilled to just above the dew point without sacrificing physical properties and resulting in faster molding cycles. It still remains important to control the chilled water temperature within close limits for successful automatic operation.

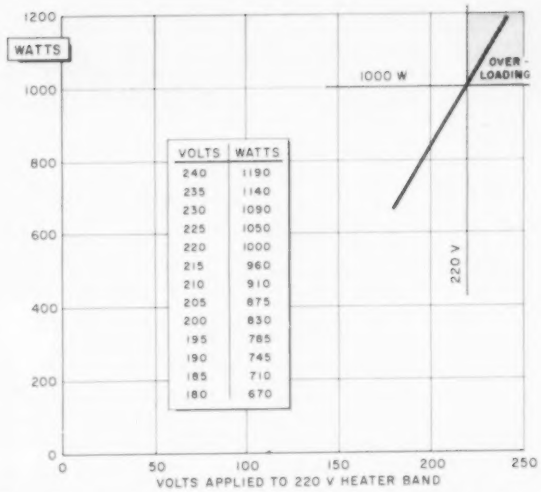

Figure 2. How voltage variation affects heater band output

Automatic Removal of Parts

One of the many functions of the human operator is removing the parts from the mold and stacking them for transfer to a subsequent manufacturing operation or packaging for shipment. When this function is taken over by machinery, "fail safe" mechanisms must be employed to insure that all the ejected parts clear the molding platens. Low pressure closing circuits are the most universally used means to interrupt the cycle and prevent damage to the mold. This technique loses its effectiveness where machine movements have been accelerated. One solution would be to discharge the parts into a tray connected to a sensitive weighing mechanism so that all parts from a multi-cavity mold would have to drop before the cycle could continue. Obviously the need for positive ejection can be seen and in some molds this can be designed so as to virtually rule out the need for a "fail safe" device.

Consideration should be given to conveyor removal of the ejected parts to an inspection and packaging area. If necessary, a sorting function can be built into the conveyor line so that parts of different size or shape can be separated and fed to various finishing areas as required. Delicate parts or those where surface appearance is important must be gently handled and sometimes will not lend themselves to an automatic take-away system. Certainly this is one area where the man with an imaginative inventive nature can have free reign.

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Casting Bibliography

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Epoxy Resins

Modern Plastics

Olefin & Terpene Epoxides, R. J. Gall & J. J. Rizzo, **Vol. 37, Mar., p. 137**
Chlorine Content of Epoxy Resins, W. J. Belanger & S. A. Schulte, **Vol. 37, Nov., p. 154**
Epoxy Styrene Foam-Putting Exotherm to Work, J. A. Struthers, **Vol. 37, Oct., p. 101**
Foam—Newest Member of a Versatile Family, H. S. Schnetzer & S. Richter, **Vol. 37, Oct., p. 99**
1958 Reference Review on Epoxies, Anonymous, **Vol. 36, Jan., p. 136**
Clear Epoxy Resin, Vol. 36, Apr., p. 58
Cast Epoxy Ring Gages, D. M. Drummond, **Vol. 36, Mar., p. 97**
Measurement of Stresses in Cast Resins, A. J. Bush, **Vol. 35, Feb., p. 143**
Evaluation of Casting Resins Employing Strain Gage Techniques, R. M. Sampson & J. P. Lesnick, **Vol. 35, Feb., p. 150**
Bis (Aminophenol) Sulfones as Curing Agents for Epoxies, W. Rueggebert, J. E. Singley, C. E. Feasel & E. A. Verchot, **Vol. 35, Feb., p. 154**
Effect of Gamma Radiation on Epoxy Plastics, J. D. Strong, **Vol. 35, Oct., p. 180**
Expendable Molds for Casting Epoxies, Vol. 34, Feb., p. 90
Epoxy Parabolic Mirrors, Paul B. Archibald, **Vol. 34, Aug., p. 116**
Low Toxity Aliphatic Amines for Cross Linking and Poly-Epoxy Amines, C. F. Pitt, **Vol. 34, Aug., p. 125**
Polysulfide-Epoxy Compositions, E. H. Sorg & C. A. McBurney, **Vol. 34, Oct., p. 187**
Epoxy Ether Resins—A New Technology, E. G. Shur, **Vol. 33, Apr., p. 174**
Polyamide-Epoxy Resins, D. Floyd, W. J. Ward & W. L. Minarek, **Vol. 33, June, p. 238**
Low Cost Molds for Short Runs, A. M. Creighton, Jr., **Vol. 33, Nov., p. 121**
Where & How to Use Epoxies, J. Formo & L. Balstead, **Vol. 32, July, p. 99**
Processing of Epoxy Resins, Vol. 32, Apr., p. 164
Alloying With Epoxies, J. Charlton, **Vol. 32, Sept., p. 155**
Epoxidation-Hydroxylation Reactions, F. P. Greenspan, **Vol. 31, Mar., p. 123**
Recent Developments With Epoxy Resins, Vol. 30, Aug., p. 130
Cast & Casting Thermosett, Max Hilrich, **1959 Modern Plastics Encyl.**

Electrical Manufacturing

Design Use of Casting Resins, W. A. Gammel, **Vol. 62, Sept., p. 80**
Evaluation Tests for Epoxy Casting Resins, M. V. Goodyear & J. P. Hornburg, **Vol. 1957, Sept., p. 123**
Epoxy Resins, Henry Lee & Kris Neville, **McGraw-Hill Publ. Co.**

Product Engineering

Cast Epoxy Models, A. W. Wakeman, **Vol. 1959, Dec., p. 58**
Three Dimensional Photoelasticity, Vol. 1959, July
Epoxy Castings, Vol. 1957, June, p. 153

SPE Journal

The Dynamic Mechanical Properties of Epoxy Resins, D. H. Kaelble, **Vol. 15, Dec., p. 1071**
Epoxy Novolacs, D. D. Applegath, R. F. Helmreigh & G. A. Sweeney, **Vol. 15, Jan., p. 54**
Calculating PHR for Epoxies, G. Epstein, **Vol. 14, Apr., p. 50**
New Epoxy Resins, J. Bassin, **Vol. 14, May, p. 36**
High Temperature Epoxy, J. M. Thomas, **Vol. 14, May, p. 39**
Cure Shrinkage of Epoxy Systems, Vol. 14, July, p. 22
Aggregate Reinforcement for Cast Epoxies, T. Delmonte, **Vol. 13, Aug., p. 23**
Dermatosis & Epoxy Resins, E. N. Dorman, **Vol. 13, Aug., p. 25**
Control of Chemical & Physical Factors In the Application of Casting Resins, Vol. 12, Nov., p. 26

SPE Preprints

A Heat Conductive Epoxy Formulation for Low Cost Molds, R. T. O'Connor & H. J. White, **Vol. 6, Paper 15**
Organic Phosphorus Epoxide Copolymers, L. M. Kindley, L. P. Glekas & P. E. Ritt, **Vol. 6. Paper 69**
Heat Resistant Encapsulating Resins, Max M. Lee, **Vol. 5, Paper 22**
Glass Microballoon Spheres, W. R. Cuming, H. E. Alford & E. Veatch, **Vol. 5. Paper 74**
A New Chlorinated Epoxy Resin, Dr. H. Cooke, Jr., **Vol. 5, Paper 77**
Reactive Diluents in Epoxy Resins, F. E. Pschorr & E. N. Dorman, **Vol. 5, Paper 78**
A Unique Modifier for Epoxy Resins, H. D. Barnstorff, H. D. Cummings, J. A. Connor, A. Y. Coran, **Vol. 5, Paper 79**
Refractive Index Method for Determining Cure Rates of Epoxy Resins, Hans Dannenburg, **Vol. 5, Paper 80**
Material Handling of Epoxy & Polyester Resins, W. A. Gammel, Sr., **Vol. 4, Paper 109**
Heat Resistant Epoxy Systems, J. E. Carey & F. C. Hopper, **Vol. 4, Paper 123**
Characteristics of Flexible Epoxy Resins, W. J. Belander, H. C. Klassen, **Vol. 4, Paper 8**
The Use of Heat Resistant Epoxy Formulation for Producing Low Cost Molds for the Plastics Industry, R. T. O. Connor, **Vol. 4, Paper 66**
Polysulfide Liquid Polymer Epoxy Resin Compounds in Plastic Tooling Applications, E. H. Sorg & A. J. Breslau, **Vol. 3, Paper 553**
A Method for Determining the Epoxy Content for Cured & Uncured Resins, PB151150-OTS U.S. Dept. of Commerce, Wash. 25. D. C.
Epoxy Resins, Irving Skeist, **Reinhold Publishing Co.**

Plastics Technology

Plastic Solves a Casting Problem, Anonymous, **Vol. 14, Jan., p. 60**
Determining Epoxy Contents of Cured & Uncured Resins, H. C. Anderson, **Vol. 5, July, p. 40**
Examining the Heat Distortion Behavior of Plastics, Van Cleve & Cosner, **Vol. 5, Sept., p. 60**
Heat Distortion Properties of Polysulfide Polymer-modified Epoxy Resins, A. J. Breslau, **Vol. 3, Apr., p. 291**

Epoxies

British Plastics

Epoxide Resin Systems for Encapsulating Large Electrical Components, G. F. Powell & R. E. Stolton, **Vol. 32, Aug., p. 380**
Epoxide Resins—A Literature Survey, B. I. Buck, **Vol. 32, Oct., p. 475**

Journal Applied Chemistry

The Curing Mechanism of Epoxy Resins, Fish Hofman & Koskekallis, **Vol. 6, Oct., p. 429**

Journal Polymer Science

Controlled Boron Trifluoride Catalysis of Epoxy Polymerizations, H. B. Wagner, **Vol. 26, Dec., p. 329**

Ind. Engineering Chemistry

Anhydride Curing Agents for Epoxy Resins, H. R. Weiss, **Vol. 49, July, p. 1089**

Chemical Processing

New Look for Epoxy Plastics With Diepoxides, Vol. 22, Mar., p. 57

Journal of Chemical & Eng. Data

Epoxysiloxane Casting Resins, E. P. Plueddemann, **Vol. 5, p. 59**

Industrie Plastiques Moderne

Epoxy Resins: Manufacture, Properties and Applications, M. Rivat-Lahousse, **Vol. 8, June 1956**

Rubber World

Chemical-Loaded Molecular Sieves as Curing Aids, June 1958, p. 424

Plastics World

Characteristics of New 600°F. Epoxy Compounds, Dr. Henry Lee, **Mar. 1958, p. 4**

Western Plastics

New Flexible Epoxy Resins, J. Delmonte, **Vol. 5, Mar. 1958, p. 29**

Machine Design

Epoxy Foams, D. D. Scott, **Vol. 30, June 1958, p. 127**

Chemical & Eng. Data

Some Correlations Between Mechanical Properties & Structure of Epoxy Resin Castings, J. Wynastra, **Vol. 3, Oct. 1958, p. 294**
Some Anhydride Curing Agents for Epoxy Resins, F. W. Michelotti, C. J. Knuth & A. Bravely, **Vol. 4**

SPE Epoxy Resin Sym. L. A., Cal., Nov. 1956

The Chemistry of Modifiers for Epoxy Resins and Their Effect on Properties, K. R. Cranker
Liquid Amine Hardeners for High Temperature Epoxy Resins, J. Philipson
Epoxy Resin Adduct Hardeners, F. G. Firth
Three Epoxy Resin Systems for Elevated Temperature Use and The Effect of Cure Cycle on Heat Distortion Point

Plaste Und Kautschuk

The Determination of Hydroxyl Groups in Epoxy Resins (in German), A. Bung & Fr. Kadlecek, **Vol. 5, Feb. 1958, p. 43**

Kunstoff-Rundschau

Epoxy Resins in Patent Literature (in German), G. Teives, **Vol. Feb-Mar.-April 1957**
Heat Aging Characteristics of Bis-Phenol Epoxy Resins (in German), P. Nowak & E. Steinbacher, **Vol. 48, Dec. 1958, p. 558**
The Measurement of Dimensional Stability at Elevated Temperatures (in German), W. Gohl, **Vol. 49, May 1959, p. 228**

Ind. & Engineering Chemistry

An Epoxy Resin from Phenophthalein, E. S. Lo, **Vol. 52, #4, Apr., p. 319**
Epoxy Resins Based on Epoxidized Soybean Oil & Het Anhydride, C. Sillardo & B. O. Schoepfle, **Vol. 52, #4, Apr., p. 323**
Epoxy Resins from Resorcinol-Acetone Condensation Products, C. L. Segal & J. B. Rust, **Vol. 52, #4, Apr., p. 324**
Pyromellitic Dianhydride in Curing of Epoxy Resins, Field & Robinson, **Mar. 1957, p. 369**
Flame & Heat-Resistant Epoxy Resins, Robitschek & Nelson, **Oct. 1956, p. 1951**
Surfactant-Treated Minerals as Reinforcing Fillers, Feb. 1956, p. 297
Flame & Heat-Resistant Epoxy Resins, Robitschek & Nelson, **Oct. 1956, p. 1951**
Effect of Filler Particle Size on Resins, Aug. 1954, p. 1635
Rheological Viscosity Changes in Thermosetting Resins, Vol. 45, Dec., p. 2748
Epoxy Resins from Bis.-Tris-, and Tetrakris-Glycidyl Ethers, Dearborn, Fuess, MacKenzie & Shepherd, **Vol. 45, Dec., p. 2715**

Chemical Processing

Easy to Regulate Epoxy Resin Cures, Anonymous, **Nov. 1955, p. 42**

Chemical Engineering Progress

Using the Epoxy Resins, Witten Wyler, **Feb. 1956, p. 53**

ASTM Bulletin

Relationship Between Electrical and Mechanical Properties of Epoxy Resins, J. Delmonte, **Sept. 1957**

British Journal of Applied Chemistry

The Photoelastic-Behavior of Cross-linked Polymers, Z. Tuzi, K. Kawata & I. Hori, **Vol. 9, May 1958**

Insulation

Some Thermal Aspects of Epoxy Resins, H. Lee & E. Klopfenstein, **Vol. 4, Feb., p. 13**

Journal of Organic Chemistry

Reaction of Epoxides with 2-Aminobenzenethiol, Kerwin, McCarthy & Vanderwerf, **Vol. 24, Nov., p. 1719**

Furane Plastics, Inc.

Epocast Technical Bulletins: Epocast 4B-EP-56-2 (Mod. 2), Epocast 4D-EP-56-54 (Mod. 3), Epocast 7D-EP-56-3, (Mod. 3), Epocast 9B-EP-56-36 (Mod. 3)

Dow Chemical Co.

Dow Epoxy Novolac Technical Bulletin

General Mills, Chemical Division

Gen Epoxy Technical Bulletin 10A

Food, Machinery & Chemical Corp.

Technical Bulletin #1 New Epoxy Resins

Jones Dabney Company

Technical Bulletins: Epi-Rez 504-35 Reference 995-49, Epi-Rez 504-36 Reference 995-50, Epi-Rez 510-44 Reference 995-26, Epi-Rez 510-45 Reference 995-17, Epi-Rez 510-75 Reference 995-47

Metachem Resins Corp.

Technical Data Bulletins: Meta-Cast #405-DB-405-360, Meta Cast #405AP-DB-405A-P-560, Meta Cast #426-DB-426-560, Meta Cast #427-DB-427-560, Meta Cast #441-DB-441-560

Durez Plastics Division Hooker Electrochemical Corp.

Het-Anhydride Bulletin #43, Het-Anhydride Coanhydride Systems for Epoxy Resins, Bulletin, #19

Emerson & Cuming, Inc.

Technical Bulletins: 7-2-10 Stycast 2651-Gen Purpose Stycast
Epoxy Casting Resin: 7-2-10A Stycast 2651MM Low Viscosity
General Purpose Epoxy Casting Resin

National Engineering Prod., Inc. Data Sheet-Castiplast #11 & #17

Bakelite C-8 Epoxy Resins, Bulletin #2, Union Carbon & Carbide Corp., Bakelite Div.

Shell Chemical Corp.

Technical Bulletin, Ren Plastics
Technical Bulletin, RP 3200 Casting Resin

Devcon Corporation

Bulletin #Nl-103, Bulletin D-10, Bulletin D-3

The Marblette Corp.

Technical Bulletins, Maraset Epoxy Resins

Houghton Laboratories, Inc.

Technical Data Bulletin T22-A, Technical Data F.C.S., Technical Data T 26 A

Polyesters

Modern Plastics

Evaluation of Casting Resins, Employing Strain Gage Techniques, J. P. Lisnick & R. M. Sampson, **Vol. 35, Feb., p. 150**
Casting Rigid Parts of Polyesters (Abstract), Vol. 33, Apr., p. 180
New Transparent Polyesters, Vol. 31, Oct., p. 107
High Temperature Properties of Stypol, F. G. Singleton, **Vol. 30, Nov., p. 152**
Exotherm Curves for Cold Setting Polyester Resins, F. C. Nichols & C. H. Bliss, **Vol. 29, May, p. 129**

British Plastics

Analysis of Polyester Resins by Infra-red Spectroscopy, R. F. Gusenthwaite, **Vol. 32, Sept., p. 428**

SPE Journal

An Easy Way To Control Polyester Resin Cure, R. B. Bennet, **Vol. 15, Oct., p. 858**
Effective Use of High Temperature Resistant Polyesters, J. P. Walton, **Vol. 15, July, p. 567**
Castable Conductive Plastics, W. C. Turner, **Vol. 15, Mar., p. 216**
Polyesters and Their Applications, 1956 New York—Reinhold Publishing Co.

Pittsburgh Plate Glass Co.

Selectron Technical Data Sheets

Rohm & Haas Co.

Paraplex "P" Data Sheets

Acrylics

Modern Plastics

Methyl Methacrylate Monomers Containing Unsaturated Polyester Resins, Vol. 35, Mar., p. 134
Accelerating Effect of Amines On Polymerization of Methyl Methacrylates, G. M. Brauer, R. Davenport, W. Hansen, Vol. 34, Nov., p. 153
Casting Plastic Sheets, J. O. Beattie, Vol. 33, p. 56
Embedding in Acrylics, A. J. Spilner, Vol. 31, Nov., p. 129
Cast Acrylic-Styrene Lens, Vol. 29, Sept., p. 188
Acrylic Embedments, Vol. 28, July, p. 93
Applications of Cast Acrylics, Vol. 28, Dec., p. 59
Monomeric Acrylic Esters, E. H. Riddle, Reinhold Publ. Corp.,
The Art of Large Area Aesthetic Embedments, W. A. Williams
S.P.E. Technical Papers, Vol. 5, Paper #25
Embedding Specimens in Methagrylate Resins, Rohm & Haas Co.

Phenolic Resins

Modern Plastics

Phenolic Duplicating Masters, Vol. 30, p. 52
Phenolic Casting Resin for Mold Making, Vol. 30, Sept., p. 98
Stages in Cast Phenolics, Vol. 30, Aug., p. 136
Phenolic Casting in Flexible Molds, Vol. 30, Sept., p. 176
Thermosets Liquid & Cast, Max Hilrich, Modern Plastics Ency., 1959

Phenolics

Durez Casting Resin Manual, Durez Plastics Division, Hooker Electrochemical Co.,
Technical Bulletin, American Resin Corp.
Data Sheet, Rezolin, Inc.
Data Sheet, Applied Resins Corp.
Technical Bulletin, Marblette Corp.

Modern Plastics

Lightweight Melamine Casts, Vol. 30, Sept., p. 212
Technical Bulletin EP58-51 & EP56-44, Furane Plastics

Polyamide

Polyamide Resins, Donald E. Floyd, Reinhold Publishing Co.

Allyls

Modern Plastics

The Allyl Resins, L. Lynn, Vol. 31, Oct., p. 139
Use of CR-39, Vol. 30, Mar., p. 156
Heat Resistant Copolymers of Triallyl Cyanurate & Maleric Acid, P. Elliot, Vol. 29, July, p. 113
Embedment of Flowers, Vol. 29, Oct., p. 113
Embedment of Flowers, Vol. 29, Jan., p. 113
Cast Applications of Allyls, Vol. 28, Dec., p. 59
Selectron Data Sheets, Pittsburgh Plate Glass Company

Vinyls

Modern Plastics

Plastisol Molds for Fancy Stone Work, Vol. 36, Apr., p. 104
Plastics Steal the Picture, Dr. H. Meyer, Vol. 35, Mar., p. 141
Vinyl Cast On Paper, Vol. 34, Dec., p. 126
Expendable Molds for Casting Epoxies, Vol. 34, Feb., p. 90
Plastisol Molds, Vol. 31, Feb., p. 152
How to Make Flexible Model Molds, E. Ferrari, Vol. 31, July, p. 93
On Stage With Plastics, Vol. 30, Nov., p. 116
Indestructible Anatomical Models, Dr. McCormick, Vol. 30, Mar., p. 90
Slush Molding Molds & Techniques, E. Greenspun, Vol. 30, July, p. 97
Ship and Plane Testing Models, Vol. 30, Nov., p. 125
Foamed Vinyls From Open Molds, Vol. 29, May, p. 83
Rotation & Casting of Plastisols

SPE Preprints

Vinyl Foam, H. E. Allen, Vol. 2, p. 390
How To Make Professional Molds & Castings, 1951 Boston Plastic Service Guild
Technical Bulletin #71, Elastomer Chemical Corp.
Service Bulletin PR-1, B. F. Goodrich Chemical Co.

Polyethylene

Modern Plastics

How To Slush Mold Polyethylene, Vol. 35, May, p. 112

Silicones

Modern Plastics

Silicone Rubber Mold for Lower Model Costs, Vol. 37, Sept., p. 94
Silicone Seals for Molds, Vol. 36, Sept., p. 192

SPE Preprints

Room Temperature Setting Heat Resistant Low Density Silicone Foams, De Weyer, Vol. 4, 1958, p. 885
Silicones Product Data, General Electric Company
Technical Data, Dow Corning Corp.

Natural Rubber Latex

India & Rubber World

Latex Molds for Casting Purposes, Vol. 97, Mar., p. 35
Casting and Molding, Carl D. Clark, PhD., Standard Arts Press, Butler, Maryland

Furan Resins

SPE Preprints

From Appearance Design To Prototype Model, E. Ferrari, Vol. 3, 1957, p. 62

Polyurethane Foam

Modern Plastics

The Urethanes Grow Up
Part 1, Vol. 36, Mar., p. 91
Part 2, Vol. 36, Apr., p. 109
Part 3, Vol. 36, June, p. 101
Encased in Urethane Foam, Vol. 36, Oct., p. 89
Polyesters of Dimer Acids As Intermediate for Urethane Foams, R. P. Aylesworth, R. H. Boehringer, D. T. Moore & M. H. Smith
Radiation Absorbers, Vol. 35, Apr., p. 200

Rubber Age

Polyurethane Foams, H. K. Frensdorf, Vol. 83, Aug., p. 812

Industrial Engineering Chemistry

Compounding Polyurethanes, R. J. Ferrari, J. W. Sinner, J. C. Bill, W. F. Bruchsk, Vol. 50, July, p. 1041

SPE Journal

Formulating A Castable Polyurethane, A. J. Quant, Vol. 15, Apr., p. 298
Progress In Urethanes, M. E. Bailey, Vol. 15, Apr., p. 285

Polysulfides

Data Sheet, Coast Pro-Seal & Mfg. Co.
Technical Bulletin #12, Smooth-On Manufacturing Co.
Technical Bulletins, Perma-Flex Mold Company

Flexible Polyester—Liquid Epoxy Resin Condensates

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Polyester-epoxy resins have potential as adhesives or electrical encapsulation compositions. This article also describes a unique method for evaluating the functionality of polyesters cross-linked with diepoxides

The liquid bisphenol/epichlorohydrin epoxy resins are uniquely suited to the controlled cross-linking of carboxyl-bearing polymers. To a considerable extent this is due to the specificity of the base-catalyzed carboxylic acid/ glycidyl ether reaction (*11*):

$$RCOOH + CH_2CHCH_2OR' \rightarrow RCOOCH_2CHCH_2OR' \quad (1)$$
$$\qquad\quad \backslash\ /\qquad\qquad\qquad\quad |$$
$$\qquad\quad\ O\qquad\qquad\qquad\quad OH$$

(In the absence of a base catalyst the above reaction is complicated by an etherification reaction

$$—CH— + CH_2CHCH_2OR' \rightarrow —CH— \quad (2)$$
$$\quad |\qquad\ \backslash\ /\qquad\qquad\quad |$$
$$\ OH\qquad\ O\qquad\qquad\ OCH_2CHCH_2OR'$$
$$\qquad\qquad\qquad\qquad\quad |$$
$$\qquad\qquad\qquad\qquad\ OH$$

which has been demonstrated to be a preferred reaction under these conditions (*7, 11*).)

Some of the potential utility of the cross-linking of carboxyl-containing polymers by diepoxides is indicated by certain patents (*1, 8, 9*) describing the epoxy resin curing of acrylic acid-other vinyl monomer copolymers. These copolymers described in this prior art are characterized by having a large number of carboxyl groups per molecule (hereinafter referred to as the "carboxyl functionality" of the polymer). That these copolymer/epoxy resin condensates are rather tightly cross-linked as a result of this high carboxyl functionality is evident from the properties reported for these products, for example the high degree of solvent resistance, etc. of coatings based on them. Although one might reasonably expect more flexible thermoset products from copolymers having low carboxyl functionalities, such copolymers would be difficult to prepare with any degree of uniformity with respect to carboxyl because of the wide molecular weight distribution of most vinyl polymers and because of the wide monomer distribution in most vinyl copolymers.

On the other hand, the esterification of a polyol with an excess of a polycarboxylic acid is much more likely to produce a polymer having a uniform distribution of carboxyl. As an illustration, consider the esterification of a diol with an excess of a dicarboxylic acid:

$$(n)\ HOROH + (n+1)\ HO_2C\text{-}R'\text{-}CO_2H \rightarrow$$
$$HO_2C\text{-}[R'\text{-}CO_2RO_2C]_n\text{-}R'\text{-}CO_2H + (2n)\ H_2O \quad (3)$$

Although the product of this polyesterification will consist of a wide distribution of molecular weight species(*6*), each of the molecules will necessarily have a carboxyl functionality of 2. Polyesters of this type and their condensation products with glycidyl ether resins have been mentioned in the patent literature (*2, 3, 5*); it should be pointed out, however, that the product of Equation 3 represents an idealized structure which is only approached asymptotically. Furthermore, if one wishes to obtain a thermoset product, on curing with a diepoxide, a carboxyl functionality somewhat greater than 2 will be required; one method of accomplishing this is by the incorporation of a minor amount of a polyfunctional (≥ 3) reactant, either acid or alcohol, in the polyester formulation.

Functionality Calculations on Polyesters

Because any one set of polyester raw materials can be used to make an almost infinite variety of polyester compositions, it was thought highly desirable to have some more systematic method of evaluating polyesters cross-linked with diepoxides than a purely empirical approach. A very useful guide has been found in (number-average) carboxyl functionality; the derivation of an equation to calculate this parameter follows the general approach used earlier to calculate certain compositional functionalities of alkyds (*10*):

Consider a system of (poly) alcohol and (poly) acid reactants in which

N = total number of starting molecules
C = total number of starting carboxyl groups
H = total number of starting hydroxyl groups
W = yield (weight) of the expected product.

On reaction, hydroxyls and carboxyls disappear to form

ester; the number of hydroxyls can decrease from H to zero while carboxyls decrease from C to C-H. The degree of esterification at any time may be determined from the relationship

$$(1\text{-}OH/OH_o)$$

where OH and OH_o are the hydroxyl values of the polyester and the (calculated) initial value. The product

$$H(1\text{-}OH/OH_o)$$

is equal to the number of ester groups formed (or the number of carboxyl groups consumed); the number of carboxyl groups remaining is then given by the expression

$$C\text{-}H(1\text{-}OH/OH_o)$$

By definition, the acid number AN of the product (acidity per unit weight) is

$$AN = \frac{C\text{-}H(1\text{-}OH/OH_o)}{W}$$

Transposition of this equation yields the following relationship

$$H(1\text{-}OH/OH_o) = C\text{-}AN \cdot W$$

the left hand member being the expression previously given as the number of ester groups formed. The quantity "W" although readily calculable, can be replaced with a reference acid value (so that the two acid values form a ratio and, therefore, can be expressed in any convenient units) by making use of the acid number definition again. The acid number AN_o of the initial charge prior to any esterification is given by

$$AN_o = C/W_o$$

Because water is a by-product of the polyesterification, "W_o" is only approximately equal to "W" above; equating the two, however, will cause only an insignificant error in further calculations in the specific examples of interest here. Making this substitution yields the following expression for the number of ester groups formed in the product at any time:

$$C\text{-}AN \cdot W = C\text{-}C \cdot AN/AN_o = C(1\text{-}AN/AN_o)$$

If one makes the assumption that esterification proceeds only intermolecularly, each ester group formed reduces the total number of molecules by one. Therefore, the total number of molecules present at any instant is given by either

$$N\text{-}(C\text{-}AN \cdot W) = N\text{-}C + AN \cdot W$$

or

$$N\text{-}C(1\text{-}AN/AN_o)$$

The number of carboxyls remaining is given by

$$C\text{-}(C\text{-}AN \cdot W) = AN \cdot W$$

or

$$C\text{-}C(1\text{-}AN/AN_o) = C \cdot AN/AN_o$$

By definition, then, the carboxyl functionality is

$$f_{coon} = \frac{AN \cdot W}{N\text{-}C + AN \cdot W}$$

or

$$f_{coon} = \frac{C \cdot AN/AN_o}{N\text{-}C(1\text{-}AN/AN_o)}$$

Following the same attack one can also derive an expression for the degree of polymerization

$$\overline{DP} = \frac{C/2}{N\text{-}C(1\text{-}AN/AN_o)}$$

Table 1. Functionality Calculations on Some Adipic Acid-Diethylene Glycol-Glycerol Polyesters

Composition A	Molar Charge Ratios	Composition B
24	Adipic Acid	17
20	Diethylene Glycol	10
1	Glycerol	3
	Parameter Values for Equations	
48	C	34
45	N	30
43	H	29
9.701	AN_o, meq./g	10.306 q
1.010	limiting AN* meq./g	1.516
1.91	Calc'd Esterification Functionality	1.933

Functionality, DP Calculations

AN	f_{coon}	DP	AN	f_{coon}	DP
1.30	1.87	7.0	2.20	2.23	5.2
1.20	2.02	8.2	2.00	2.54	6.5
1.10	2.23	9.8	1.80	3.07	8.8
1.05	2.37	10.9	1.60	4.14	13.4
1.010	2.50	12.0	1.516	5.00	17.0

* Limiting acid number is the calculated acid value at which hydroxyl concentration has been reduced to zero and beyond which, therefore, the acid number cannot be run.

when defined as the number of (dibasic) acid residues in the average polyester molecule. Another useful parameter which should be calculated for polyesterification before even making other calculations might be described as the esterification functionality of the system

$$f_{ester} = 2H/N$$

and is derived directly from the consideration that the number of functions used in an esterification reaction is equal to two times the number of functions in deficiency. If the esterification functionality calculates to greater than 2, the polyesterification process will surely give a gelled product before a high degree of esterification can be reached. Previous experience would suggest that an esterification functionality of 1.9 or even slightly higher can be managed. (In some cases, gelation can actually occur below the theoretical value of 2; this is due to the inadequacy of number-average calculations. Weight-average calculations, while more trustworthy, are much more difficult to make.)

Experimental Details

Polyesters based on adipic acid, diethylene glycol and glycerol can be used to illustrate the potential, performance wise, of polyester-epoxy resin combinations and also the utility of the mathematical expressions given above. Before any experimental work was attempted, several excess acid polyester formulations were analyzed on paper. The first criterion was an esterification functionality of 1.90 to 1.95; formulas meeting this requirement were then examined further as to carboxyl functionality and degree of polymerization as a function of acid number. *Table 1* illustrates these calculations for the case of two adipic acid-diethylene glycol-glycerol polyesters.

The molar proportions of reactants noted in *Table 1* (properly scaled to fit the reactor) were charged to a three-necked flask fitted with mechanical agitation, a thermometer reaching the liquid level and a Dean-Stark trap plus reflux condenser. A quantity of xylene equal to eight percent by weight of the expected product yield was also added and the batch heated to reflux, water being removed as formed.

Table 2. Properties of Two Polyesters from Adipic Acid, Diethylene Glycol and Glycerol

	Composition A	Composition B
Acid number, meq./g.	1.18	1.80
Combining weight, g./COOH	848.	556.
Carboxyl functionality	2.05	3.07
Viscosity (cs. at 25°C.)	11,700	35,200
Stoichiometric polyester/ERL-2774 ratio	82/18	74/26

Table 3. Curing of Two Adipic Acid-Diethylene-Glycol-Glycerol Polyesters and Blends of Them with ERL-2774

Composition	C	D	E	F	G
Polyester A	—	21.2	42.4	63.6	84.8
Polyester B	55.6	41.7	27.8	13.9	—
ERL-2774	19.4	19.4	19.4	19.4	19.4
Benzyldimethylamine	0.75	0.82	0.90	0.97	1.04
Calc'd f_{COOH}	3.07	2.85	2.56	2.30	2.05
Shore "A" hardness values when cured					
1 hr./150°C.	50	40	32	14	10
4 days/50°C.	15	10	(a)*	(b)*	(c)*

* (a) Not thermoset—acidity = 0.32 meq./g. or 71% conversion
* (b) Not thermoset—acidity = 0.35 meq./g. or 66% conversion
* (c) Not thermoset

Table 4. Some Calculations on "Empol" 1022 (Neutral equivalent found: 294)

Species	Weight	M.W.	Moles	Funct.	COOH	Corrected*
Dimer	71	560	0.1268	2	0.2536	0.2415
Trimer	26	840	0.0310	3	0.0930	0.0885
Monomer	3	280	0.0107	1	0.0107	0.0102
	100		0.1685			0.3402

* by the factor 280/294.

Table 5. Composition and Properties of Some Dimer Acid-Diethylene Glycol-Glycerol Polyesters

Composition	J	K	L
95% Glycerol	0.85	1.71	2.14
Diethylene Glycol	11.61	10.28	9.60
"Empol" 1022	87.54	88.01	88.26
Acidity, meq./g.	0.70	0.63	0.64
Combining Weight	1430.	1580.	1565.
Carboxyl Functionality	2.0+	2.6	2.8
Viscosity, cs., 25°C.	43,500	81,600	246,000
Stoichiometric ratio polyester/ERL-2774	88/12	89/11	89/11

After the desired acid value had been reached, the polyester was freed from xylene by distillation. See *Table 2* for properties.

Table 2 also gives the stoichiometric weight ratio of polyester to epoxy resin ERL-2774—that is, the proportion yielding one carboxyl to one epoxide group. Such blends, when catalyzed with one (weight) percent benzyldimethylamine, cured to thermoset structures within an hour at 150°C. To obtain a first approximation of the relationship of carboxyl functionality to physical properties of the cured condensate, blends of these two polyesters were cured with ERL-2774 as illustrated in *Table 3*.

As this table indicates, hardness increased regularly with increasing carboxyl functionality; stiffness also increased in the same manner. Toughness, however, decreased in the series, Composition C, for example, having somewhat the characteristics of art gum whereas G was reasonably tough and tear resistant. *Table 3* also illustrates the degree of cure that might be expected under much more mild conditions; a brief but unsuccessful effort was made to find a catalyst which might allow a more complete conversion under these conditions, but the results were completely negative.

More flexible thermoset polyester/epoxy resin condensates were found in an evaluation of dimerized soya acids in polyester formulations. Functionality calculations were again used as a screening tool, the approximate molar compositions of these acids as given by the producer (*4*) being used to obtain the information of *Table 4*.

The indicated numbers of moles and of carboxyls per unit weight of dimer acids were used in functionality calculations on several excess dimer acid/diol/triol combinations. Three such polyester compositions are shown in *Table 5*:

These polyesters were also prepared by the xylene azeotropic distillation method; the esterification endpoint was simply that point at which acidity began to decrease at too slow a rate to warrant further holding at reflux.

The indicated weight ratios of polyester and epoxy resin, each catalyzed with one percent benzyldimethylamine, cured to thermoset compositions within an hour at 150°C. Although all were thermoset and rubbery, there was a regular gradation of properties; room temperature Shore "A" hardness values varied from 2 (Composition J) to 30 (L). All of these materials also showed good adhesion to metal, suggesting that they might have some utility as adhesives or as electrical encapsulating compositions.

Literature References

1. Allenby, O. C. W., (to Canadian Industries Ltd.), U. S. patent 2,662,870 (1953).
2. Cass, W. E., (to General Electric Co.), U. S. patent 2,683,131 and 2,691,007 (1954).
3. CIBA Ltd., Swiss patent 284,090 (1952).
4. Emery Industries, Inc., "Empol 1022, Polymerized Fatty Acids," booklet EM-948A(1956).
5. Fisch, W. (to CIBA Ltd.), U. S. patent 2,712,535 (1955).
6. Flory, P. J., *J. Am. Chem. Soc.*, 58, 1877-85 (1936).
7. Hickenbottom, W. J., Hogg. D. R., *J. Chem. Soc.*, 1954, 4200-5.
8. Schroeder, J. P., (to Union Carbide Corp.) U. S. patent 2,784,128 (1957).
9. Segall, G. H., Cameron, J. L., (to Canadian Industries Ltd.) U. S. patent 2,798,861 (1957).
10. Shechter, L., Wynstra, J., *Ind. Eng. Chem.*, 47, 1602-4 (1955).
11. Shechter, L., Wynstra, J., *Ind. Eng. Chem.*, 48, 86-93 (1956).

Presented at the Division of Organic Coatings and Plastics Chemistry Symposium on Plasticized Thermosetting Systems, American Chemical Society New York Meeting, September, 1960.

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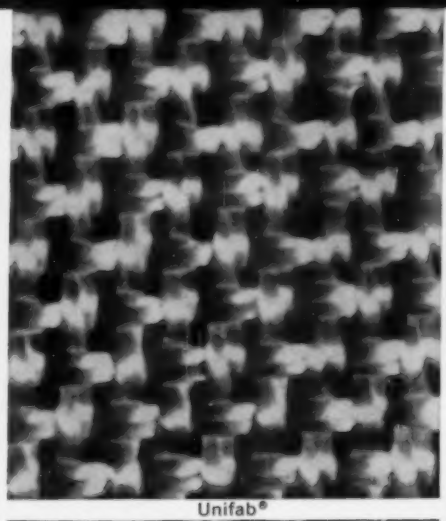

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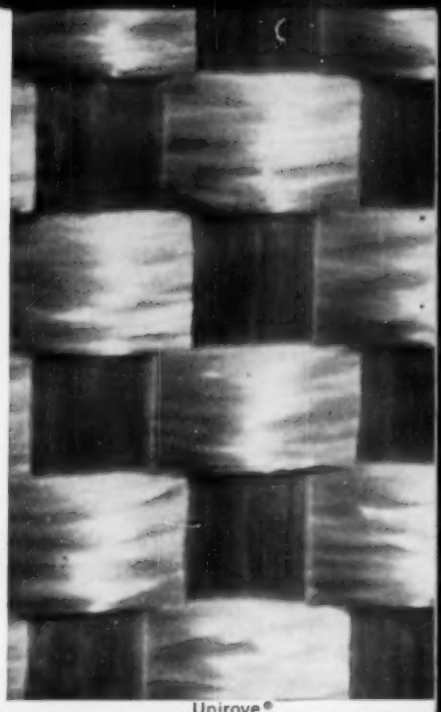

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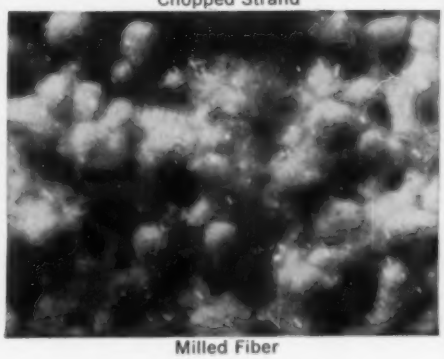

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SOCIETY ACTION

SPE Membership—

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Joseph Grenier

Chairman, SPE Membership Committee
(Protective Closures Co.)

As our Society continues into 1961, we can look back over the years of growth in maturity and membership with considerable pride in the accomplishments of those who have contributed so much to its success. Although in the development of any organization there must always be a small percentage of men who deserve special honor for outstanding service and accomplishment, every member should realize that he plays an important role in building his Society.

Our International Membership Contest for 1961 has already begun. This year there will be two international champions. One banner will go to the winning Section with over 200 members and one to the Section with less than 200 members. Also, as before a regional banner will be awarded to the Section in each region with the greatest percentage increase in applications received. The Sections that can display these banners have certainly earned the honor and prestige they give.

Why Membership

There is good reason why membership in the Society increases the stature and prestige of the individual plastics engineer in the industry. Through many outlets, such as Technical Conferences, both International and Regional, the SPE Journal, and local Section Meetings, the information necessary to keep a man current in his knowledge and thinking is being constantly disseminated. In this age when new materials and processes are constantly developing, plastics companies are time and again finding it necessary to diversify their plastics efforts. The active SPE member is, by far, the more valuable man to his company because he keeps well informed, not only in his narrowly specialized field, but in the whole broad area of plastics.

When it is necessary for a company to institute new processes and methods to remain competitive, it will turn to a man with a *broad technical* knowledge of the entire plastics field.

During the past several months, business conditions in the country at large have been somewhat depressed. Many members, for one reason or another, have become delinquent in their dues. There is always a tendency during such periods for individuals to run scared, to cut expenditures wherever possible. But mature thinking will make a man realize that *this is the time to keep current*, to employ to the best advantage the SPE Journal, the technical conferences and other functions of the Society, thus contributing vigorously to his company's efforts. During slow business cycles, *the man who keeps up-to-date is never in trouble.*

Student Membership

An important phase of our Society activities is our Student Membership Program, ably headed by Dr. Russell Ehlers of the Lowell Technological Institute. The plastics industry is one of the few billion dollar industries in our country. Young people who plan engineering careers should have some technical knowledge of plastics. Though their careers may lead them into other industries, this knowledge is invaluable in helping them to specify plastics, when needed.

One of the problems of the industry today is the complete ignorance of the potentials of plastics by many engineers in industries which could use plastics, but which are not directly concerned in their manufacture or processing. The importance of Student Membership and Student Chapters to the future of plastics and to our Society cannot be stressed too much. Several Sections have already held highly successful student visitation meetings.

Before the end of the year we should have several Student Chapters in our Society.

Society Growth

Today, the SPE is the major single source of technical information for the plastics engineer. This is because we have grown in numbers to the point where really active PAG's, with the best talent in the various branches of our industry, gather and disseminate knowledge; where enough excellent papers are available for Technical Conferences and our various publications to maintain a constant flow of technical information. As membership increases, the services of the Society will improve. Every time one of our members encourages a prospective member to join, he is performing a valuable service: to the new member, to himself, and to the Society. If every member would set a goal of *one new member this year*, the value of the Society to each individual member would be multiplied tenfold. Let's make this a banner year for the SPE!

THE ENGINEERING BOARD—

A New Concept

in your Society's Management

James R. Lampman,

SPE Vice President, Engineering, and
Chairman, SPE Engineering Board (General Electric Co.)

Progress requires change. Your Society is dedicated to progress which will benefit its membership. As a result of planning and forward thinking started some three years ago, the Society today boasts a new plan of action for its officials. Published in the March, 1961 issue of the SPE Journal, the Organization Chart graphically depicts the new lines of authority. All action is now centered in the hands of the two Vice Presidents—a Vice President, Engineering and a Vice President, Administration—reporting, of course, through the SPE President to Council and its Executive Committee.

These Vice Presidents obviously do not take direct action, but attempt to coordinate through their Boards the activities of the Engineering or Administrative Committees assigned to their respective Boards. This article is written to explain the composition and functions of the Engineering Board only. A later article will define the Administrative Board.

Ten SPE Standing Committees have been assigned to the Engineering Board. These are:

1. Technical Information
2. Inter-Society Relations
3. Plastics Institute
4. Publications
5. Editorial Advisory Board
6. Technical Volumes
7. PAG Executive
8. Education
9. Meetings
10. Technical Program

Each Committee is assigned to one of two Vice Chairmen who serve as administrators. To provide liaison with the SPE Executive Committee, the two Vice Chairmen are appointed from the membership of the Executive Committee. Committees one through six above are administered by Vice Chairman, Samuel H. Greenwood. Committees seven through ten are administered by Vice Chairman, Carl H. Whitlock.

It is easily seen that the work of one Committee does not stand by itself alone, but is related to the activities of other Committees. Each may take action or recommend action which affects the picture and the work of other Committees and the Society's future besides! For this reason alone, the Engineering Board must be made aware of the proposed actions of any Committee. The Board may then approve, or recommend a different plan which will allow a more unified or more rapid approach to the goals of the Society.

It is equally obvious that additional planning produces more new concepts which relate to the long-range plans of the Society, the Plastics Industry and individual members themselves. Keeping these relationships in mind is the second job of the Engineering Board, so that the policies and procedures found best may be applied uniformly to all Committees. In this way objectives desired by the SPE membership are most readily translated into direct action. In some cases, a request for action may be made which is to the benefit of one group but which may be detrimental to others. The Engineering Board must stand ready to prevent such one-sided action.

Since this new concept of Society management was adopted by Council on January 23, 1961, your Engineering Board has held two meetings—one on January 25, 1961, in Washington, D. C., and the second on April 3, 1961, in Worcester, Massachusetts. It is gratifying to report that these two meetings have clearly demonstrated that the foregoing principles and philosophy, upon which the Board is based, are sound, practical, and effective.

In summary, then, here is your Engineering Board. One Chairman, the Vice President, Engineering; two Vice Chairmen; and ten Committee Chairmen. Together they will coordinate their actions, plan for future growth and stimulate and encourage engineering actions which tend to strengthen and enlarge the influence of the Society of Plastics Engineers in the professional and industrial world of plastics. As the Society grows and increases in influence so, too, does each man whose membership makes up the Society.

—— ■ ——

edited by **Thomas A. Bissell,**
SPE Executive Secretary

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PLASTICS AROUND THE WORLD

This month's column has been made possible through the contributions of these abstracters:
Hans Mayer (Industries Des Plastiques Modernes)
G. Gruenwald (Kunststoff-Rundschau and Kunststoffe and Plaste Un Kautschuk)
L. S. Buchoff (Materials in Design Engineering)
Philip G. Fleming (Mechanical Engineering)
A. Baczewski (L'officiel Des Matieres Plastiques)
Alfred Alk (Materie Plastiche)
Alexander Baczewski (Penze Plastiques)
Evert A. Mol (British Plastics)

West Germany

KUNSTSTOFF-RUNDSCHAU

FEBRUARY 1961

Vacuum metalizing by Dr. J. Moll—pp 57-62

The paper describes the vacuum metalizing process in general terms. Two tables with specific data compare different methods of decorating plastics for obtaining a metallic look and the readiness of various materials for vacuum metalizing. Industrial equipment for mass production and for metalizing films are briefly delineated.

JANUARY AND FEBRUARY 1961

Polyolefin Pipe Extrusion by H. Domininghaus—pp 19-23, 62-69

This article gives an excellent description of the work on polyolefin pipes, which was published or patented during the last years (113 references). Since it does not get lost in unimportant details but mentions many handy practices, it is recommended to everybody interested in plastic pipes. Various extrusion, calibration, and take-up equipment are described, the strengthening of the pipe by stretch-orienting at about 125°C is discussed. Long-time strength requirements and measurements, environmental stress cracking, and also the possibilities for fastening or burying of plastic pipes as well as for making detachable and permanent pipe connections are covered. On account of his company affiliation with Germany's most advanced high-density polyethylene producer, the emphasis is laid on their Ziegler-type product, but low-density polyethylene, polypropylene and PVC are also considered.

Italy

MATERIE PLASTICHE

DECEMBER 1960

A Colossal Machine for Injection Molding Thermoplastic Resins—pp 1160-3

Officine A. Triulzi has unveiled a gigantic press capable of injecting 12 Kg. at each shot. It was built for a German firm which plans to mold refrigerator cases. Two other machines are in process and a 20 Kg. press is being planned. The preplastification capacity of the press is 350 Kg. per hour: the platens are nearly seven feet square. Construction details and illustrations are presented in the article.

Black Polyethylene—pp 1140-7

The addition of Carbon Black to polyethylene is the most effective method of reducing photochemical degradation.

JANUARY 1961

Macroplastic 1960—pp 3-32

Thirty pages of this issue comprising descriptive text and seventy-seven illustrations are devoted to the Second International Plastics Fair at Utrecht, Holland, October 19-26, 1960.

JANUARY 1961

Plastics at the Automobile Show Turin November 3-13, 1960—pp 33-41

More illustrations of new cars and new applications of plastics in the transportation field.

JANUARY 1961

French Packaging Oscar 1960—pp 50-63

The French Packaging Institute annually awards Oscars. This year they were given to those firms which made the greatest contribution to the protection and presentation of all kinds of products. Descriptions and illustrations.

FEBRUARY 1961

Swedish Packaging—pp 152-163

A report on the European Package Federation meeting in Stockholm last September and some notes assembled during the author's Swedish voyage. Illustrated with color plates.

FEBRUARY 1961

Plastics in Irrigation—Part I—pp 117-132

This profusely illustrated article is devoted to the storage and transportation of large quantities of water for agricultural purposes. Italy had 1,776 artificial lakes in May, 1959, which contained nearly 70 million cubic meters of water.

FEBRUARY 1961

Applications of Montivel in The Packaging Field—pp 189-196

Other articles have examined Montivel polyester film in electrical and decorative applications. The author here describes packaging foods, liquids of various kinds and medical supplies in the plain film and in laminates. Physical properties are summarized. Packaging machinery using Montivel is illustrated.

U.S.A.

MATERIALS IN DESIGN ENGINEERING

NOVEMBER 1960

Automobiles—What materials are next?—p 143

Acetal is used in a parking brake pulley and dashboard instrument housing because of its high strength and rigidity and elevated temperature service. New faster production techniques must be developed before reinforced plastics replace metal in regular passenger cars.

Polypropylene's low cost, toughness and scratch resistance led to its use in radio grills and windshield washer reservoirs. Polyethylene is used in seat side shields because of weight and cost savings. Nylon is used in 50 car parts including gears and bearings. Polyurethane foams are replacing latex foams in upholstery because of their higher strength and tear resistance.

What Users Think of Polypropylene—pp 117-126

Polypropylene's low cost and heat resistance are the main reasons for its use. Other advantages are

its rigidity, greater than polyethylene, dependence of rigidity on thickness and excellent flex life permitting the integral hinge, resistance to chemical attack, and stress cracking.

Disadvantages include difficulty in marking polypropylene, difficulty in getting smooth surfaces, lack of uniform processing, low temperature brittleness, and varying performance characteristics from different suppliers.

MECHANICAL ENGINEERING

DECEMBER 1960

Materials Briefs: Epoxy-Resin Concrete Repairs—p 77

Adhesives and binders containing epoxy resins are being used by the California Division of Highways to repair concrete. Under favorable conditions, repairs have been opened to traffic within three to five hours.

Plastic-Lead Compound can be Applied with Trowel—p 56

A 94 percent lead and 6 percent thermosetting plastic compound which is room-temperature curing, and requires no pressure during the cure cycle, is available from E. P. Barrus, Ltd., London, England. Set-time of the compound is approximately three hours after addition of the hardening agent.

France

L'OFFICIEL DES MATIERES PLASTIQUES

JANUARY 1961

Foamed Resins by R. Hybre—pp 33-41

Foamed Polyethylene, having a dielectric constant of 1.50 only is used in coaxial cables and television antennas. Much work has been done in the field of polyurethanes, e.g. by using castor oil as a coreactant, molybdates as catalysts and by incorporating colorants in the starting materials. A method has been found to make cellulose sponges rot resistant. Very light and mechanically strong foams have been made from polycarbonates by German chemists.

FEBRUARY 1961

Non-supported films by J. Delorme pp 127-134

Rigid poly(vinylchloride) has to be stabilised with a Ba-Cd epoxy complex. All other stabilisers contribute either noxious odors or poor color. Nylon 6 (poly caprolactam) is easier to extrude than Nylon 6-6 (hexamethylenediamine-adipic acid). Polyethylene-coated nylon has been used for canned sardines, etc.

FEBRUARY 1961

Foamed resins by R. Hybre pp 135-137

Alginate foams are solvent proof and non-inflammable.

INDUSTRIE DES PLASTIQUES MODERNES

JANUARY-FEBRUARY 1961

A Study of Lacquers and Application Methods in Connection with High Vacuum Metalization of Plastic Parts by C. F. Spiess

Before the high vacuum metalization of plastic parts can be undertaken with any hope for success, a pretreatment of the plastic parts, usually lacquering, is required. This will permit good adhesion and prevent the development of blisters and peeling of the metal in places where gases will escape through the original surface.

The Use of Polyethylene in the Dairy Industry of Scandinavia by F. A. Abardie-Maumert

Polyethylene Pipe Lines are being used in Norway to pipe milk from the mountains into valley processing plants. Polyethylene milk cans and closures—molded from high pressure material—are replacing the conventional metal containers at great savings in weight.

PENSEZ PLASTIQUES SPECIAL ISSUE ON BUILDING

4th QUARTER 1960

Face Panels and Curtain Walls anon—pp 3 to 7

Insulation against heat, cold and moisture are treated. Field trials prove that neoprene compounds make the best gaskets.

United Kingdom

BRITISH PLASTICS

JANUARY 1961

High Density Polythene Monofilament by E. Overgage and G. John—pp 10-14

Monofilaments are made by extrusion and orientation. The article describes the best conditions for extrusion, such as the shape of the dies and the water bath temperature and level. The orientation is done in hot water between two sets of rolls turning at two different speeds. The relative speeds, of course, determine the drawing ratio or degree of orientation. The takeup should operate under constant tension and entrapment of the filament must be avoided. The properties of the end product depend on the grade of polythene. Maximum tenacity is obtained with minimum melt index. The filaments can be colored, preferably with inorganic films, because of their better heat stability.

JANUARY-FEBRUARY 1961

Radiation Chemistry and Polymer Technology, Parts 1 and 2, by S. H. Pinner—Jan. pp 30-33, Feb. pp 76-80

This is an excellent survey strongly recommended for anyone that wants to get acquainted with the radiation field in a hurry. The survey is mainly based directly on patent literature, and those discussed are confined to American and British patents. The breakdown is interesting in that it reveals that G. E. is far ahead of all other participants in number of patents. G. E. is, of course, interested in both design and sale of radiation equipment and in the manufacture and sales of radiated plastics such as Irrathene.

FEBRUARY 1961

New Specifications for Polyurethane Foam in Upholstery—pp 73-74

The growth of the polyurethane foam industry made it necessary to set standards and specify testing methods for same. The article discusses partially the indentation hardness index, indentation modulus, tensile strength and elongation, compression weight, apparent density, static indentation test and heat aging.

FEBRUARY 1961

Polyester Resins for Coating Applications by T. L. Phillips—pp 69-72

The paper discusses mainly the inhibition of curing by atmospheric oxygen. Three ways of overcoming this inhibition are presented: (1) the addition of skin forming agents such as paraffin waxes, (2) the use of more chemically sophisticated molecules, and (3) baking. The use of beta gamma unsaturated ethers built into the polyester molecules is discussed in detail.

LIGHT STABILITY OF STYRON® VERELITE® IN FLUORESCENT-LIGHTING DIFFUSERS

A major problem with polystyrene plastics commonly used in designing fluorescent light diffusers has been early yellowing. As engineers know, this is essentially an oxidation type process, and the degree of yellowing (or loss of light transmittance) is a measure of the molecular breakdown of the plastic. With unstabilized plastics, degradation can be so severe as to cause warpage, distortion and reduced strength.

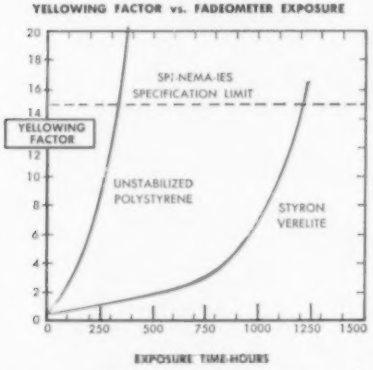

Fig. I —Improved stability of Styron Verelite

The villain in the piece is primarily ultraviolet radiation from the fluorescent tube. The presence of U.V. radiation greatly speeds the oxidation process, in which oxygen breaks the carbon-hydrogen bonds. By the use of suitable additives, however, polystyrene formulations can be produced which will stand up for many years before the degree of yellowing reaches industry limits. One such material is Styron Verelite polystyrene.

Discoloration limits have been agreed upon by a joint industries lighting committee—The SPI-NEMA-IES*. The maximum tolerable yellowing limit set by the committee is expressed as a yellowing factor of 15. Yellowing factor is determined by the equation:

$$\text{Yellowing factor} = \frac{(T_{420_B} - T_{420_E}) - (T_{680_B} - T_{680_E})}{T_{560_B}} \times 100$$

where T = % light transmission at given wave length
B = blank
E = exposed

In shorter-term Dow studies on methods of improving light stability of polystyrene plastics, the Atlas Fadeometer is used for purposes of accelerating test results. This device has a carbon arc light source which provides light of essentially the same frequencies U.V. radiation as cool white fluorescent light tubes, but at much higher intensities. A correlation has been established between exposure in this machine, and actual long-term exposure to cool white fluorescent tubes, at varying diffuser-to-tube distances. For example, 1250 hours' exposure in the Fadeometer is equivalent to approximately 4½ years' continuous exposure in a light fixture with half-an-inch clearance between the plastic diffuser and a cool white tube. With increased spacing the discoloration rate is even slower.

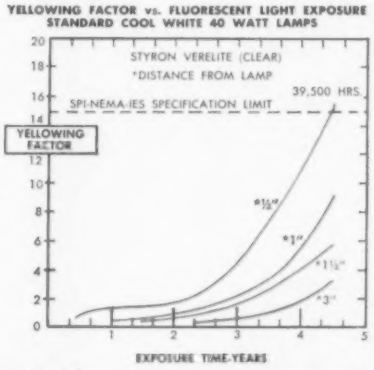

Fig. II—Effect of clearance space on rate of discoloration.
Note similarity for curves (Fadeometer and ½" spacing in fixture)

On the basis of these data—accelerated aging in the Fadeometer and performance in actual installation—Styron Verelite has proven suitable for fluorescent light diffuser paneling. Using the industry average of 60 hours per week, satisfactory performance for as long as 10 years can be expected.

Dow Plastics Technical Service Engineers have developed considerably more data on Styron Verelite as a light diffuser material. Included are the new translucent whites and more recently the high intensity lamps. For information on the results of these studies, and on the selection and application of other Dow molding materials in design work, write THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Dept. 1732EX5.

The Society of the Plastics Industry—National Electrical Manufacturers' Association—Illuminating Engineering Society.

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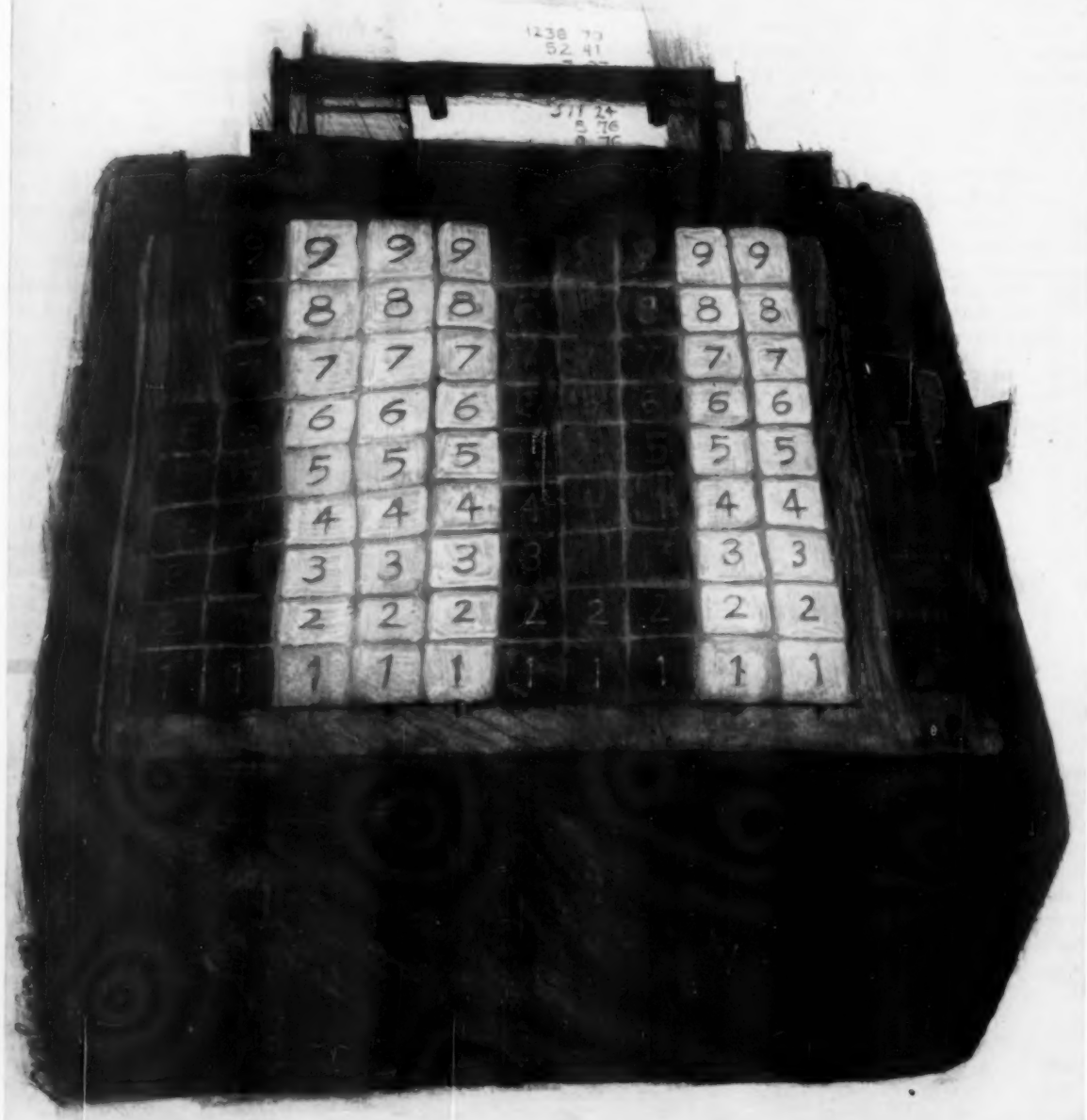

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SECTION NEWS

Central Ohio

Central Ohio Display for National Engineers' Week

DICK SHARPE
(Westinghouse Electric Corp.)

As their part in the celebration of National Engineers' Week, the Central Ohio Section constructed an SPE, multi-colored display in the lobby of one of the Columbus, Ohio, banks during the week of February 19-25. It demonstrated the role the local plastics industry plays in the advancement of plastics engineering and related national and local purpose, history, and accomplishments. Co-operating companies were Battelle Memorial Institute, Columbus Plastic Products, Hydraulic Press Mfg. Co., Lincoln Molded Plastics, The Plastex Co., Westinghouse Electric Co., and Yardley Plastics Co.

Northwest Pennsylvania

Speakers Featured at Winter Meetings

LLOYD ENGLISH
(Louis Marx Co., Inc. of Penna.)

At a dinner meeting on February 23 at the Eagles Club, Section President, Fred Kraft, called upon Program Chairman, Mr. Clifford Scantelberry, to introduce the speakers of the evening, Mr. W. C. Jenner and Mr. J. Tierney, of Hysol Corporation. Mr. Tierney, Manager of Tooling Applications, gave a talk on the various uses of Epoxy materials in tooling illustrated by colored slides and actual sample tools made of Epoxies.

The dinner meeting March 23 was attended by 68 members and guests who heard Mr. John M. Slabough of Prospect Mold & Die Co., Cuyahoga Falls, Ohio, discuss plastic and mold design. Covering the subject from the general point of view of the mold builder, mold user and mold designer, he discussed the principal steps involved in creating a design and offered a number of specific examples of problems and common errors.

Miami Valley

Opportunities Unlimited In Plastics Engineering

Melvin V. Roode (General Motors Corp.)

Keynoting the program of the Miami Valley Section's dinner meeting on March 3 at the Engineering Society Headquarters in Cincinnati was Mr. H. Burrell, Manager, Resins Development Laboratory of the Interchemical Corp. and lecturer at Xavier University. His talk was "Plastics Technology and its Implications." Following a movie on Plastics Technology, a panel discussion was held with the following participating: Dr. P. W. Crane, Vice-President and Director of Research of The Cincinnati Milling Machine Co.; Mr. J. R. Twining, Manufacturing Superintendent, Monsanto Chemical Co.; Mr. R. H. Reiger, Technical Representative for the Union Carbide Plastics Co. and Mr. C. J. Hannon, Treasurer of the Formica Corp.

Connecticut

Provocative Programs Mark Winter Meetings

K. G. Clarke
(E. I. du Pont de Nemours & Co., Inc.)

The February meeting featured a discussion on the Rheology of Plastisols by Mr. Arnold Werner of Naugatuck Chemical Division U.S. Rubber Company, Naugatuck, Conn.

After a general discussion of terms used in rheology, Mr. Werner explained that viscosity in Newtonian fluids (motor oil, water) is a fairly easily defined property. However, for non-Newtonian fluids (mayonnaise, mustard, and plastic melts and solutions) such phenomena as dilatant flow and thixotropy make viscosity somewhat more complex. For such fluids, viscosity is not a constant but varies with shear stress, shear rate, and time.

Mr. B. G. Lowe of the Risdon Manufacturing Co., Naugatuck, Conn., attracted both buyers and sellers to hear "What the Vendor Means to the Vendee." He traced the history of the vendor-vendee relationship from early times when dishonesty and skulduggery were the rules, to the present state of mutual professional cooperation on a much higher level.

Milwaukee

Section Meetings Enjoy Record Turn-Outs

C. H. Strong (Union Carbide Plastics Co.)

The Milwaukee section's February meeting began with a delicious smorgasbord dinner with 90 members and guests including four university students present. This was one of the largest attendance records and everyone on hand appreciated the fine talk given by Mr. M. N. Paul, Technical Service Manager, Union Carbide Plastics, on new epoxy resins. He discussed the chemistry and various applications with formulations of the new epoxy resins recently developed by Union Carbide.

In March, the Section welcomed an honored guest to its meeting at the Bavarian Club on the 27th. Mr. John Berutich, SPE National Treasurer, discussed the financial aspects of the national office. Principal speaker was Mr. H. S. Tenney, Jr., Dow Chemical Co. His subject: styrene isocyanate and polyethylene foams. Included were some observations on flame resistant importance. His conclusion was based on a new technology for polyethylene foam.

Central New York

Student Visitation Day . . . A Hit

J. R. Lampman (General Electric Co.)

Bad weather couldn't keep an enthusiastic group of 50 away from the Section's meeting featuring Mr. Stanley Norris of the DuPont organization discussing "Welding and other Methods of Joining Thermoplastics." The fine talk was illustrated with slides and color motion pictures. There was so much interest generated by his remarks, that questioners remained after the meeting!

Nineteen students visited eight area industrial plants during the afternoon and were invited to participate in the activities of the engineers to whom they were assigned. Comments from the students were very favorable with many expressing a desire to repeat the experience.

New York

For May . . . Fillers in Plastisols

A. E. Whitney, Jr.
(Goodyear Tire & Rubber Co.)

May 17 the New York Section of the SPE Vinyl Group will hear Mr. Irwin L. Podess of Irwin L. Podell, Inc., speak on "Fillers in Plastisols." To complete the program, there will be another speaker discussing fillers for vinyls.

One of the jobs Carl Fischer finds his 350TCL—12/16-oz. REED particularly well suited to is a 14½-oz. high impact styrene shot for the outer case of a Royal Shoe-Master electric buffer. For full details on this or any REED model, call your nearest Reed-Prentice Sales Engineer.

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Philadelphia

Dual Topic Meeting

George R. DeHoff
(E. I. du Pont de Nemours & Co., Inc.)

On March 28 the Philadelphia Section had approximately 150 members and guests present for its third dual topic meeting. This popular double program has resulted in a 50% increase in attendance. The two topics were the "Characteristics of Vinyl Plasticizers" and "Plastics in Building and Construction."

Chairman R. A. Parker of Firestone Plastics Co. had three speakers to cover vinyl plasticizers. Mr. D. H. Bechtold, Monsanto Chemical Co., discussed "Effects of Processing Conditions and Plasticizer Choice on Physical Properties of Polyvinyl Chloride." Mr. J. D. Farr, Emery Industries, Inc., spoke on "The Effect of Polymeric Plasticizers on Processing Characteristics and Physical Properties of PVC." Mr. W. H. Bauer, Union Carbide Chemical Co., gave further diversification to the subject with a paper on "Low Temperature Plasticizers."

Mr. R. V. Bridi, Koppers Co., served as chairman of the building and construction session. He introduced Mr. E. A. Edburg, also from Koppers Co. who spoke on the problems associated with gaining acceptance of plastics in the construction industry. Through the efforts of SPI and the associated companies, progress is being made and today polystyrene, polyethylene, acrylics, vinyls and glass re-inforced polyesters are being used in building. A film on the construction of two research homes using foam core panels and other plastics was shown. In one of these rigid vinyl was used for hot water piping.

Newark

New Developments In Injection Molding

R. E. Christensen (Union Carbide Plastics Co.)

The Newark Section met at the Military Park Hotel on March 8th. Following dinner, a discussion of advances in injection molding was presented by two speakers.

Robert G. Michel, Technical Supervisor, Plastic Forming Machinery, Con-O-Pac Corporation, New York, N.Y., discussed "Rotating Turret Type Injection Molding." He described the operation and applications of the Rotojet Injection Molding Machine, which was invented by Mr. Raymond Collion of Lyon, France. This machine incorporates the use of a simple screw extruder to pre-plasticize the material and a revolving turret having six or eight pistons to which the molds are mounted. The rotating turret automatically indexes the molds to the injection station where the molds are successively clamped and fed material from the transfer cylinder at the end of the extruder, followed by indexing to the cooling stations. At present there are four models of this type of machine being manufactured in Lyon, France, ranging in shot size from five to fifty grams. The high speed molding of the Rotojet machine was demonstrated in a film. The second speaker was Mr. Ernest P. Moslo, President of Moslo Machinery Co., Cleveland, Ohio. Mr. Moslo spoke on "Improved Injection Molding," discussing the general principles of importance to the molder.

Rochester

Painting and Decorating Plastic Parts

D. L. Messenger (General Dynamics Corp.)

The March meeting was held at Logan's on March 13, 1961. Mr. George Hill, Vice President, presided.

Our speaker, Mr. Raymond Pinter of Eastman Kodak's A & O Division, spoke on the painting and decorating of plastic parts. Mr. Pinter emphasized that with proper preparation and the right material, almost any plastic part can be painted if necessary. He brought several samples of molded parts which have replaced metal and visually it was very difficult to tell the difference.

Baltimore-Washington

Developments In Adhesives

Stanley P. Prosen

(U.S. Naval Ordnance Laboratory)

On March 14, the Baltimore-Washington Section heard a delightful presentation by Dr. Richard F. Blomquist of the U.S. Forest Products Laboratory, Madison, Wisconsin, on "Developments in Adhesives." The meeting was held at Langley Park, Maryland, and was the Washington March meeting of the new split schedule of the Baltimore-Washington Section.

Dr. Blomquist discussed why adhesives are being used more and more, what the adhesive bond depends on, the selection of adhesives, the design of adhesive joint, types of adhesives, and applications of adhesives in wood structures.

Because of the greater knowledge of the bonding process brought about by tough military requirements being met and good experience with bonded products, the user is accepting the adhesive bond as a practical manufacturing technique. Adhesives allow the user to acquire bonds where it is impossible to bond with other techniques, give him higher volume production and more even stress distribution in structures.

The selection of the adhesive depends on materials to be bonded, type of joint, working properties required, the permanence of the joint and the cost. Adhesives develop strength by loss of solvent, cooling of hot melts, pressure-sensitive action, and chemical reaction. Joint designs from lap to bevelled double strap were also discussed. Illustrative slides were shown.

Golden Gate

"Implex—Its Uses and Markets"

Mike Rabin (Transparent Products Corp.)

On March 9, 39 members of the Golden Gate Section and their guests met for the regular monthly meeting at the International Inn.

Mr. Richardson, of Rohm & Haas, introduced the guest speaker of the evening, Mr. R. L. Gardner, also of Rohm & Haas. He spoke on the subject of Implex, giving in detail some of the formulations and fields in which these formulations are being used: the vending machine, automotive, and marine industries, and others. Mr. Gardner also had a number of articles that had been injection molded or fabricated from sheet Implex, showing some of the complex items than can be made. This discussion was followed by a question and answer period. Before the program began, Mr. Brant Newsom introduced Mr. C. J. Kuhre of Shell Development, who gave a brief talk about the 17th ANTEC.

Western New England

Two Speakers Spark March Meeting

Merlin L. Evans (Plax Corp.)

Mr. L. C. Pratt, Assistant Chief Engineer at Millers Falls Company, Greenfield, Mass., and Mr. E. L. Goodwin, President of Cape Cod Shipbuilding Company, Wareham, Mass., spoke at the March 1 meeting of the WNE Section held at Betty's Town House in Agawam, Mass.

Mr. Pratt, who has been handling electric motor design and development as well as a good deal of the product design for the past thirteen years, drew on his vast experience in the presentation of the development of a ¼ in. electric drill with a nylon housing. Evaluation of various materials and designs, and the development of a double installation drill were discussed and illustrated with slides.

Mr. Goodwin, described the development of the fiber glass boat and its place in the marine industry. The provocative talk provided a challenge for those engaged in this phase of the plastics industry.

Kentuckiana

Implex

George A. Polk (General Electric Co.)

The Rohm & Haas Co. presented the program for the Kentuckiana Section's March meeting. Mr. J. B. Spencer spoke on "The Properties and End Use Applications of Implex" and illustrated his talk by explaining the background of a number of Implex parts. Samples were displayed.

Mr. J. F. Moore discussed "The Processing Characteristics of Implex", giving pointers on mold and part design and the molding of this versatile material.

St. Louis, Mo.

"Thermoplastic Sheets"

Richard H. Koehrmann

(International Shoe Co.)

At the March meeting of the Saint Louis section, Mr. James Bachner of the Camco Division of Chicago Molded Products gave a talk on "Considerations Required in the Manufacture of Thermoplastic Sheets". Equipment for the production of the various plastic sheets and control methods used for maintaining gauge and regulating stress were described.

Buffalo

March Meeting . . . Annual Students' Night

Jack Valentine

(Durez Plastics Div., Hooker Chemical Corp.)

Sixteen students and two faculty members, from local schools, were guests of the Buffalo Section during the day and at the regular monthly meeting attended by thirty members. Bill Windover, Education Committee Chairman, had arranged plant tours and demonstrations.

The speaker, Mr. William Hunter, of the Celanese Corporation, gave students and members alike a fine survey of the field of plastics, with particular emphasis on cellulosics and polyolefins.

Pioneer Valley

Screw Plasticizing for Injection Molding

J. R. Johnston (Foster-Grant Co., Inc.)

Mr. Jack Fuller of the Ankerwerk Company gave a stimulating and informative talk on screw plasticizers. Mr. Fuller traced the historical development of screw plasticizers in Europe and the United States.

He pointed out that simultaneously five years ago a license was granted to Bathseda (Germany) and Egan (United States) for the commercial manufacture of screw plasticizers. The pace for development was greater in Europe than in United States because of the demand for molding difficult materials, e.g. rigid vinyl. The advantages gained in screw plasticizers are immediately recognizable.

(1) Uniform melt of material
(2) Handle all types of materials
(3) Mold heat sensitive materials easily
(4) Lower mold temperatures
(5) Lower and more uniform pressures

(6) Shorter cycle time
(7) Less strain on parts

At the present time, Mr. Fuller pointed out, approximately 90% of all molding in Europe is of this nature, and that his company has sold five hundred machines there. With respect to size, there is a 120 ounce machine and he cannot conceive of any limitations in size or speed. There are machines that yield 25-30 shots per minute.

Mr. Fuller concluded that the screw plasticizer type molding machine is a major breakthrough in the plastic industry.

Ontario

"The Rheology of Plastisols" "Formulating Vinyl Foam Plastisols"

Harold A. Shure (Naugatuck Chemicals)

Eighty-seven persons attended the S.P.E. Ontario Section meeting in Toronto on March 16th to hear Mr. Arnold C. Werner of Naugatuck Chemical discuss two papers. The first, "The Rheology of Plastisols", covered a discussion of Newtonian and non-Newtonian flow behavior of plastisols as well as other fluids. Such characteristic flow patterns as dilatancy, thixotropy, plastic flow, etc. were shown via slides. Rheological measurements using a rotational viscometer illustrated the relationship existing between shear stress, viscosity, and shear rate. A plastisol developed for fabric coating was used to illustrate the effective use of rheological measurements as a tool in evaluating compounds by duplicating in the laboratory those shear rates encountered in actual plant process.

"Formulating Vinyl Foam Plastisols" took up the formulation of chemically blown plastisol foam using Celogen and Celogen AZ as the foaming agents. Such factors as fusion time and temperature; plasticizer level and type; Celogen AZ concentration; and resin molecular weight were studied in relation to foam density and cell quality.

North Texas

Origin & Current Uses of Plastic Tooling

ERNEST F. DOURLET
(Cadillac Plastic Co.)

Mr. Herb Ellefson, Southwest Representative for Furane Plastics discussed plastic tooling at the February 20 meeting before members and guests. His prime emphasis was on the aircraft industry, but he also covered applications in the automotive and other fields.

"A Low Pressure Bag Method of Producing Hollow Reinforced Bodies"

March 20, Macon Petty, manager of the Plastics Division of Hudson Engineering Co., Houston, Texas, described Hudson's development of a variable pitch fan for use in the petrochemical cooling towers they manufacture. Since no fan blade was commercially available that was suitable for their purpose, they were forced to manufacture their own. Mr. Petty started to evaluate methods in 1952 and finally evolved a low pressure bag method on which they hold patents. With this method they are able to obtain 85% glass content in their blades. The key to the process is the use of a rising head of mercury to apply pressure to the laminate. Glass cloth and epoxy resin are used with a Dacron or Dynel layer for extra weather resistance. These blades are for fans up to ten feet in diameter. A number of fans have been operating continuously over five years and are still in excellent condition.

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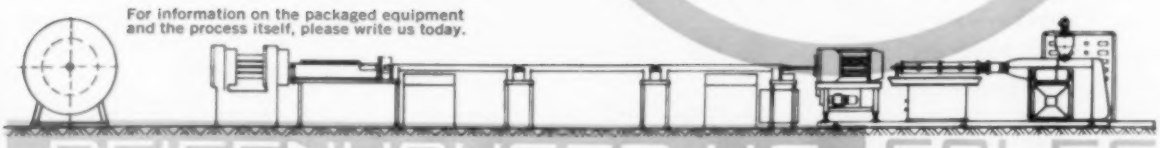

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Upper Midwest

Technical Aspects of Molding Acrylic

Charles M. Smith (Donaldson Co., Inc.)

The February meeting of the Upper Midwest Section of the Society of Plastic Engineers concerned "Technical Aspects of Molding Acrylic" presented by J. F. Moore, Technical Service, Rohm & Haas Company. Considering the number of people who attended this meeting, it is obvious that molding of acrylics is of interest to many. Mr. Moore presented a fine lecture supplemented with sample molded acrylic parts.

Southern California

Panel Discusses Nylon for Members, Students, Guests

John A. Stahmann
(Rocketdyne (Div. No. American Aviation Co.)

Chemistry students, instructors, S.P.E. members, and guests learned about the latest developments in nylon polymers from a panel of experts during the February meeting.

The students and instructors came from the University of California at Los Angeles, the University of Southern California, Los Angeles State College, and the Los Angeles Trade Technical Junior College.

Dr. Robert Lindegren of DuPont spoke about Nylon 66 and 610. Nylons are now tailor-made for performance. In the design of special resins, the ease of moldability is of concern. They must exhibit flexibility for use in bellows. They may be plasticized to prevent denting or marking when struck or impacted as in the aircraft industry applications. They may be extruded over paper, coated over wire, or laminated with other resins. Wide color ranges are available.

T. R. Von Toerne of the Allied Chemical Corporation laboratories spoke on Nylon 6, a tough semirigid resin. It is used in gears, bearings, vacuum metallized hardware, pipe, tubing, packaging of grease and oils, and in other extrusion and coating applications. He presented stress-strain diagrams which indicated very high molecular forces in the resin. Temperature and moisture environments lower the mechanical properties; however, the effects are reversible. Since moisture adsorption is slow, the resin is sensitive to the average relative humidity. Prolonged exposure to heat tends to degrade the resin.

The Many Applications For Implex

Some eighty members and guests attended the March meeting. Milton Schimmel reported progress on the the RETEC on Plastic Finishing.

Robert L. Gardner, the speaker of the evening, has been associated with Rohm & Haas for twenty years. With the Sales Development Group in Philadelphia, his responsibilities include the marketing and diversification of Implex and Plexiglas.

Mr. Gardner described Implex as a group of tough acrylics which have been on the market for approximately 3½ years. Starting with a 1958 survey and cost study analysis for the automotive industry, Implex has consistently underpriced metals in application and replaced them. The original Implex was developed for use in the ladies' shoe industry where toughness was required to prevent breakage of thin heels. To meet the requirements for deep drawn parts, a second, more workable Implex was formulated. This was followed by varieties used for piano keys and soft drink dispensers.

The strength-versus-weight ratio and the weatherability appear particularly good for Implex.

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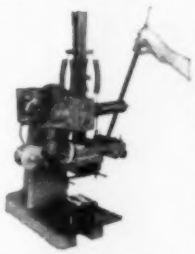

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ABOUT MEMBERS

Iver G. Freeman has been appointed Vice President and General Manager of National Cleveland Corporation's Plastics Divisions, Auto-Vac Co. and Auto-Blow Corp. Mr. Freeman heads up new centralized and expanded operations at Fairfield, Conn.

Laurence Kogos has been promoted to executive vice president of the Farrington Manufacturing Co. subsidiary, Farrington Texol Corp. Formerly vice president of the vinyl division, Mr. Kogos holds a B.S. degree in chemical engineering from Northeastern University, '51. He played a major role in the development of the Farrington Tuff-Tarp.

Harry C. Wechsler, formerly vice president commercial development, Borden Chemical Co., has been promoted to the position of vice president of the newly formed Thermoplastics Division, a consolidation of the Polyvinyl Chloride, Resinite and Polyco-Monomer Departments.

Thomas M. Corey was named vice president of production of the Diamond Plastics Division of the newly formed company, Creative Packaging, Inc. Mr. Corey had been with Diamond Plastics Industries for 12 years and was plant superintendent. The new organization represents the merger of his former company and Paper Package Co.

Elmer P. Warnken is president, director and member of the executive committee of United Systems Corp. Four existing companies each contribute a specialty enabling United Systems to undertake complete missile and space vehicle systems at lower defense costs. Mr. Warnken is also vice president of Studebaker-Packard Corp., one of the contributing companies. He is a widely recognized expert in the field of hi-temperature plastics. The other companies are Merz-Chambers Corp., Technology Instrument Corp. and Ancel Propulsion Inc., a subsidiary of Celanese Corp. of America.

Reichhold Chemicals, Inc. has announced the appointment of **Charles S. Stryker** as sales manager, Plastics Division. He will be responsible for the national sales and pricing policies, polyesters, epoxies, polyurethanes, urea and melamine resins sold to the plastics industries, as well as the sale of peroxide catalysts to all industries. He continues, too, as central management's technical liasion for the Alsynite Division and Modiglass Fibers, Inc, a subsidiary of RCI.

The promotion of **R. George Hochschild** to technical director, Polystyrene, Product Development, Plastics Division, Koppers Co., Inc. has been announced. Mr. Hochschild, a graduate of Lowell Technological Institute where he earned the B.S. and M.S. degrees in Textile Chemistry, will be in charge of polystyrene and product development activities. He has been associated with the company since awarded the Polymers Fellowship involving three years of study at the Mellon Institute of Industrial Research. Most recently he has been concerned with the development of new polystyrene materials.

Zoltan Merszei has been elected a vice president and general manager of European operations of Dow Chemical International, Ltd. S. A. He has been general sales manager for the European area, Dow Chemical International. In his new capacity, he will be responsible for all operations and functions for all Dow subsidiary and affiliated companies in Europe. His headquarters remain in Zurich, Switzerland.

William F. Christie has been appointed to a newly created position in the marketing department of Amoco Chemicals Corp. He will be director of market research in the United States. A graduate of the University of Michigan with a B.S. in Chemical Engineering, he has held positions with Escambia Chemical Corp., Ross and Roberts Co., Presto Plastics Products Co. and the Bakelite Co. before joining Amoco in 1957.

Among the retiring Technical Committee Chairmen honored with Certificates of Appreciation during the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry was **S. N. Stickel,** Texon, Inc., former Chairman of the Plastics Committee. The men were cited for their efforts on behalf of the Association.

Herbert J. Weber Dead

Active as Member-Administrator, New York Section, Community Spirited Executive succumbs at 62.

Herbert J. Weber, one of the most popular members of SPE's New York Section, died February 18 of a heart attack. He was 62.

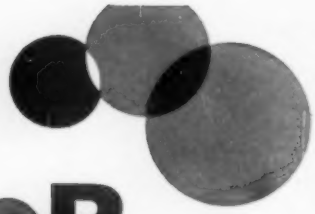
Elected to the Society in 1951, he was one of its hardest working, loyal supporters on a national as well as a local level.

Over the years he has been associated with the Koppers Co., Chester Lighting, Whiteford Plastics, Rotuba Extruders, Waljon Plastics, and late in 1960 formed his own custom extrusion company, Aard Plastics.

Keenly interested in the promotion of the plastics industry, he was instrumental in initiating and guiding many of the educational programs in the New York Section at the New York Institute of Technology, the Bronx Community College, State University Agricultural & Technical Institute at Farmingdale, and at the Machine & Metal Trades High School in N.Y.C.

He served the Society as director, secretary, vice-president and president of the New York Section, chairing many committees on the local level. Community minded as well, he was on the Board of the Machine and Metal Trades Commission of the City of New York and served as Chairman of the Plastics Educational Commission of the Advisory Board for Vocational and Extension Education to the Board of Education of the City of New York.

He attended Cooper Union Institute, studying Architecture and Chemical Engineering. He is survived by his widow and daughter.



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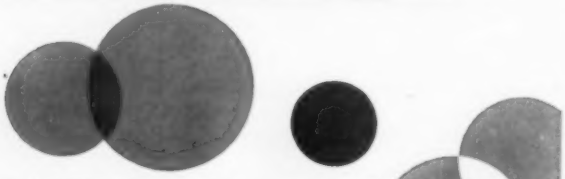

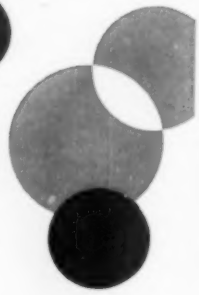

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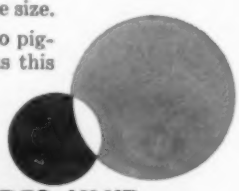

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Rotron Manufacturing Co. has named **Peter F. Grad** chief chemical engineer. Prior to joining the company, Mr. Grad was with Aerovox Corp. and the Chemical Division of the Borden Co. He holds a B.S. degree in Chemistry from the Polytechnic Institute of Brooklyn and a diploma in Chemical Engineering from Pratt Institute.

Dr. John J. Bohrer has been elected to the Board of Directors of North American Electronics, Inc. He is Director of Research, International Resistance Co.

Escambia Chemical Corp. has announced the appointment of **J. M. Martin** as sales manager, vinyl resins, with headquarters in New York City. Mr. Martin has been with the company for five years as regional sales representative and field sales manager.

David Wilbur has been appointment sales and service representative, St. Louis-Kansas City, Improved Machinery, Inc.

Herbert Schoenfield becomes assistant manager of Witco Chemical Co.'s urethane chemicals department, in charge of research and development activities, technical services and sales. He has been product sales manager of the department. His headquarters will continue to be the Chicago sales offices. Mr. Schoenfield has a B.S. in Chemistry from the Illinois Institute of Technology and a Master's from the University of Chicago.

Emile Czerwinski has been named Chief Engineer for Atlantic Plastics, Stamford, Conn. He was with Diamond Plastics Industry, Washington, D. C.

Among those assigned to work on market studies in new product areas for the Lucidol Division of Wallace & Tiernan, Inc., are **Kenneth B. Wylegals** and **Matthew V. Perry.** Mr. Wylegals has represented the company in the Northeast territory, and Mr. Perry was formerly with Armstrong Cork Co., Lancaster, Pa.

Lil Louden, Louden Co., New York City, has resigned from Lunn Laminates, Inc., Huntington Station, L. I., whom she represented for eight years. In complete charge of public relations, Mrs. Louden also represented the firm at SPE and SPI. Because of the company's growth, Mrs. Louden feels that it would operate best through its own public relations department. She will remain as consultant on special projects while she concentrates on her other clients.

Henry E. Wessel becomes director of marketing and **Dr. W. Paul Moeller,** manager, at AviSun Corp. of Philadelphia. Mr. Wessel has been manager of sales planning and Dr. Moeller was formerly with Celanese Corporation of America. Mr. Wessel is a chemical engineering graduate of Illinois Institute of Technology and Dr. Moeller received his chemical engineering degrees at Polytechnic Institute of Brooklyn.

Rogers Corp., Rogers, Conn., has appointed **David R. Dunay** regional sales manager in the Northeast. He has been with the firm since 1947 and has served in the New York City area as sales engineer.

Jones P. Sipe moves up to the position of product manager, Dulite Expandable Polystyrene and **R. R. Bench** succeeds him as sales manager of the Division's Eastern District, according to an announcement from the Plastics Division of Koppers Co., Inc. Mr. Sipe, who holds a B.S. in Chemical Engineering from the University of Pittsburgh, has been with Koppers since 1946. Mr. Bench, with the company since 1952, is a Penn State graduate with a degree in Fuel Technology.

Mr. Self

M. A. Self, President of Bee Chemical Co., was elected to membership in the Young Presidents' Organization in recognition of his attaining the presidency of a substantial corporation before the age of 40. He has held the position since 1948. The international organization is composed of 1600 company presidents in the U.S. and eight foreign countries who exchange ideas, develop personal business skills and further the free enterprise system.

James W. Thesken has been appointed sales manager, Dynatech Plastics Inc. A graduate of Los Angeles State College, Mr. Thesken was with the B.F. Goodrich Co. for the past eight years.

Leominster Tool Co. has appointed **A. F. Cossette** general manager, responsible for the sales and manufacturing of injection molds and all company products. Mr. Cossette formerly represented Standard Tool Co. of Leominster in the N. Y. Metropolitan area.

Appointments made at the Johns-Manville Research Center, Manville, N. J., to serve in the Center's New Business and Dutch Brand and Central Plastics Department include: **Dr. Robert T. Crouch** who will be manager for manufacturing and technical services; **Ralph M. Hutchison,** who takes over as plant superintendent, working under Dr. Crouch in charge of equipment, personnel and operation of the building; and **Wayne O. Jackson** who succeeds Dr. Crouch as chief of the Reinforced and Molded Plastics Section of the Department. Dr. Crouch holds a degree from Franklin and Marshall College, an M.S. and D.Sc. in organic chemistry from Carnegie Institute of Technology, and was associated with the Shell Chemical Corp. in Houston, Texas, before joining Johns-Manville in 1954.

J. B. Schmitt has been appointed manager of production for the Durethene film operations of the Plastics Division of Koppers Co., Inc. He has been with the company since 1942 and most recently was product manager for Dylene polystyrene in the Marketing Department of the Plastics Division.

Nick S. Metrocavich has been promoted to supervisor of sales and engineering, Newark Die Hobbing and Casting Co. He will be in charge of all engineering and sales phases. He has served as sales engineer for the past five years.

Dr. Frank A. Cassis, formerly group leader in the sales technical service laboratory, Amoco Chemicals Corp., has been appointed director, sales technical service planning. He holds a Ph.D. in Chemistry from Michigan State and B.S. and M.S. degrees from West Virginia University.

The National Academy of Sciences, National Research Council, has announced the appointment of **Prof. Frederick J. McGarry,** Associate Professor of Materials in the Department of Civil and Sanitary Engineering, Massachusetts Institute of Technology, to the Committee on Organic Materials of the Academy's Materials Advisory Board. He will advise in the field of reinforced plastics.

Whitlock DRYERS...

ASSURE PERFECT PLASTIC PREPARATION

Plastic materials are best prepared for maximum production and highest quality when dried and pre-heated with Whitlock Dehumidifying Dryers.

- Desert dry air (below —20°F dewpoint) under pressure from a positive displacement blower is drawn through the material insuring an ideal processing condition.
- Variable temperature control (125°F to 250°F or higher) insures material preheating to optimum temperature for fastest production, best quality products, and minimum power requirements.

Whitlock Dehumidifying Dryer features:

- Closed air system, positive displacement blower.
- Automatic desiccant regeneration.
- Air spreader at hopper throat.
- Quick-access filter chamber.
- Easy installation.

Write for full details . . . Whitlock 60-E

WHITLOCK ASSOCIATES, INC.

21655 Coolidge Highway • Oak Park 37, Michigan

Towards Better Digestion

A Message to SPE Members

Those of you who have recently advertised a "Position Wanted" in our Employment Service Guide are now familiar with our Availability File. To you, and to future member users of these pages, here are some tidbits which we have only recently acquired ourselves, that will improve the functioning of the File.

1. A potential employer who advertises with us and signs up for our pre-publication communication service is interested to learn *more* about a prospective job seeker than just the fact that he falls within one of the three broad categories of R&D, M&P or Sales Representation, into which *you* place *yourselves*. To be sure, his available opening is also in one of these categories; however, we have learned that this is insufficient information for him.

2. To save time and effort for each party involved, we attempt in abbreviated form to match job specifications with the qualifications set forth in your ad and then forward copies of the appropriate ads, pre-publication, to the companies who are advertising. Sometimes it is difficult to weed out the qualifications from the literary style used. The latter is of necessity limited by your 50 word maximum no-charge ad.

3. Since your purpose in advertising is strictly functional, we suggest that when composing your ad you incorporate the following: a) your job title as caption; b) age, educational background and degree(s), length and type of experience, location preferred (or willingness to relocate); c) minimum salary requirements, if possible. We will edit copy if punctuation or capitalization is misused.

From a recent issue of SPE JOURNAL, we reprint a good illustration of the above. It states the facts concisely.

"PROJECT ENGINEER, MANAGER—Ch.E. with thirteen years broad engineering experience. R&D project coordination, process and product development work in rubbers, thermoplastics, including extrusion of unsupported films, extrusion coating of polyolefins on various substrates. Desires responsible position in metropolitan N. Y. —N. J.—Conn. area. Box No. —, SPE JOURNAL."

Another plastics publication carried a choice example of how, in our opinion, *not* to word a "Positions Wanted" ad:

"ATTENTION PLASTICS MANUFACTURERS—It takes initiative, imagination, and infectious enthusiasm to enlist top caliber college graduates. It takes more of the same to hold them and even more to inspire them to be productive. Let me show you why I qualify. Reply Box —, Publication X." In fact, this illustration is so choice that we, ourselves, cannot tell what qualifications he has, nor which type of position he seeks!

So that we may best serve you, our members, we hope to interest more employers in the value of using and reading our Employment Service Guide. It will be to the mutual advantage of each if you will stipulate only the meat and potatoes—and save the dessert for later.

Classified Advertising Department, SPE JOURNAL

CO·REZYN

Polyester Resins · Gel Cotes and Color Pastes

Easy Handling Gel-Cotes

For the operator who has Gel-Cote problems, Co-Rezyn offers better curing, easier handling to improve production methods. Available in 16 bright, stable colors, Co-Rezyn Gel-Cotes are stocked for immediate delivery. Write for Free Color Card.

COMMERCIAL RESINS CORPORATION

594 James Avenue

St. Paul 2, Minn.

ABOUT MEMBERS

Promoted to product manager, Polystyrene, Plastics Division, Koppers Co., Inc., is **S. M. Robertson**, Western District sales manager. He will be headquartered in Pittsburgh. He has been with Koppers since receiving his degree in Chemical Engineering at Cornell University.

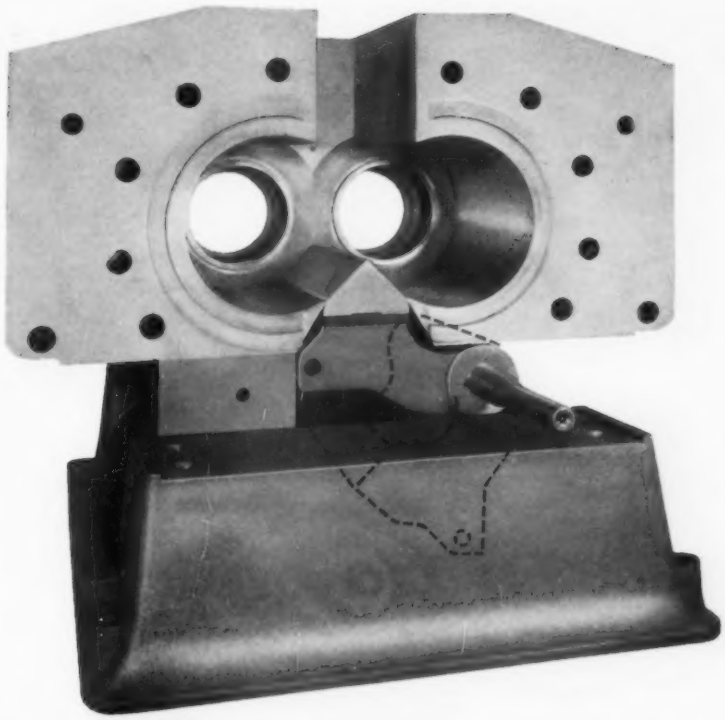
R. J. Sweitzer heads the new Plastics Division formed by the Lock Joint Pipe Co., East Orange, N. J. He will serve as general manager. The division will function as liaison with the company's recent and all future acquisitions in the plastics field and Mr. Sweitzer will direct policy, sales production and operations of the subsidiaries in the division.

C. Burton Wing has been named district sales manager, Boston, by the Plastics Division of Allied Chemical Corp. He has been with the firm over 18 years.

James F. Mayer has been appointed a group leader at the Amoco Chemicals sales technical service laboratory. He served as chemical engineer on the staff.

R. W. Broadbent has been promoted to account manager in the Cleveland sales office, Dow Chemical Co. He has been a field salesman for five years. Only 12 salesmen in the company hold this rating, given in recognition of superior achievement, and experience.

Holding a newly created position in the marketing department of Amoco Chemicals Corp. is **R. Wayne Yelverton.** With the company since 1958, he has had various assignments in commercial and technical development. A graduate of the University of Florida, he has been associated with Koppers Co., Gibson Associates, and in various manufacturing positions.



ONE OF MANY WAYS

Banbury® mixer design meets the needs of plastics processors

Using knowledge gained through close association with plastics manufacturers, Farrel is continually improving Banbury mixer design. Shown above is one recent innovation: the hydraulically operated drop door.

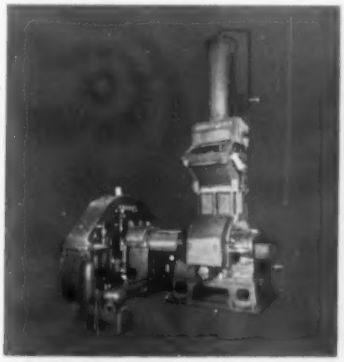
Hinged so that its tapered edge swings up to make line contact with the mixing chamber, this design eliminates the leakage inherent in sliding doors. There are never any "rattails" left to contaminate the next batch. Its quick action (under 2 seconds) is valuable when working with sensitive plastics at critical temperatures.

Banburys come in two types — with cored or spray sides — to meet any processing need. Capacity, rotor speed, pressures and types of surfacing material — whether Stellite, chrome-plate, stainless steel or dual-metal for lining — are dictated by the application. Standard features include roller bearings and self-sealing dust stops.

Send for bulletin 207. It will bring you up to date on Banbury design.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, Akron, Chicago, Los Angeles, Houston, Atlanta
European Office: Piazza della Republica 32, Milano, Italy

FARREL®



Left: Size 9D Banbury with spray-cooled sides for most efficient cooling can also be used with up to 15 pounds of steam for moderate heating.
Right: Size 3D Banbury with cored sides, recommended for use where high machine tempetatures are necessary.

FB-1206

*Johnson reel (Denison-Johnson Corp.); Imperial 8 radio (Admiral Corp.); Aqua Hone sharpener (Sun Enterprises, Inc.)

IMPLEX in a man's world

IMPLEX, the high impact acrylic, goes where the tough jobs are . . . where great strength and rigidity, plus resistance to staining, are important selling points for a product. The fishing reel cover, transistor radio case and water-powered knife sharpener housing shown above* have rugged durability because they are molded of IMPLEX. This Rohm & Haas molding material also provides an attractive appearance by imparting high surface gloss and rich colors. Our design staff and technical representatives will be pleased to help you use IMPLEX for your present and prospective products—to your advantage. Just write and tell us about a specific project.

ROHM & HAAS

PHILADELPHIA 5, PA.

In Canada: *Rohm & Haas Co. of Canada, Ltd., West Hill, Ontario*

IMPLEX *is a trademark, Reg. U.S. Pat. Office and in principal foreign countries.*

IMPLEX

New Materials and Equipment

So that you can get the information you want in the shortest possible time, we suggest you write directly to the company address listed at the end of each new product item.

MATERIALS AND APPLICATIONS

New Colors in Acrylic Sheet

Eight new outdoor stable shades for Plexiglas acrylic plastic sheet have been made available in the most widely used sizes as well as on a custom basis. Meeting the demand for fade-resistant shades for architectural applications, internally illuminated signs and numerous other indoor and outdoor locations, the new colors were selected after extensive study by the manufacturers. Contact *Dept. SPE,* **Rohm & Haas Co., Plastics Dept., Washington Square, Philadelphia 5, Pa.**

Improved Curing Agent

In combination with low viscosity epoxy resins, a new curing agent, Araldite DP-121A, produces coating systems that can be applied in single-coat dry-film thicknesses of 5-10 mils. The finishes are said to be hard, tough, flexible films, with high gloss and good chemical resistance. Since they are solventless, the fire hazards are minimized. For information, *Dept. SPE,* **CIBA Products Corp., Fair Lawn, N. J.**

White Polyethylene Produced for Improved Blending

A 45% concentrate white polyethylene which can be blended with any of the company's polyethylene extrusion and film resins to suit specific end use requirements has been introduced by Monsanto. It is designated with the number, 6407 and is compounded with Monsanto's polyethylene 70 and a rutile titanium dioxide pigment said to reduce screenpack and non-uniform pigment feed. The new material would give extruders and extrusion coaters maximum inventory control and flexibility with savings in production and improvements in quality. For details, *Dept. SPE,* **Monsanto Chemical Co., Plastics Div., Springfield, Mass.**

Low Viscosity Epoxy Resin

Lower cost, less skin sensitizing, a pleasant odor, higher flexural strengths and lower vapor pressure are claimed for a new low viscosity, modified epoxy resin. Modification with a reactive diluent is accomplished during manufacture to produce the new resin, Araldite DP-310. Suggested for use in adhesives, solventless coatings, electrical encapsulating compounds, flooring, laminating and tooling. Check with *Dept. SPE,* **CIBA Products Corp., Fair Lawn, N. J.**

Cast Epoxy Rod

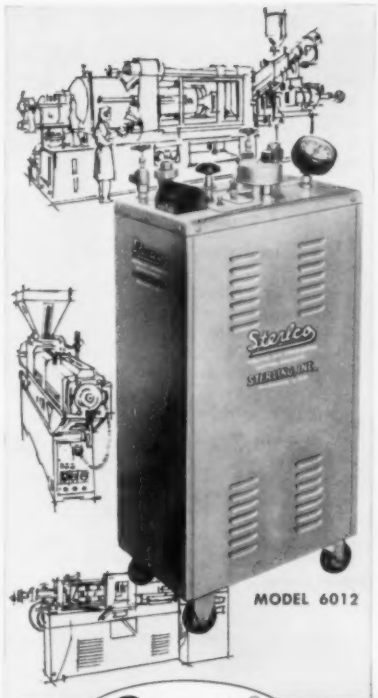
A new plastic material, which, according to the manufacturer has been formulated to meet the most rigid specifications when used for precision wire-wound resistors can now be supplied. The new series, BMCO 2000, is available in standard colors and diameters with a wide selection of various types and percentages of inert fillers. Features of the material include high volume resistivity at high temperatures and high heat distortion. For details, *Dept. SPE,* **Boonton Molding Co., Boonton, N. J.**

New Synthetic Resin

"Pentalyn 225" is a new resin exhibiting a broad range of compatibilities with a high softening point hard and friable at room temperature. Applications stemming from its unusual combination of properties include use in flexographic and glycol-soluble inks, overprint lacquers, and polymer-type emulsions, particularly those suited for dry-bright polishes. Versatile and economical. *Dept. SPE,* **Hercules Powder Co., 910 Market St., Wilmington 99, Del.**

New Felt-Type Fabric

A new material, designated Fiberloc, stronger than many felts with greater resistance to wear and decomposition has been manufactured of synthetic fibre, bonded by a technique that en-

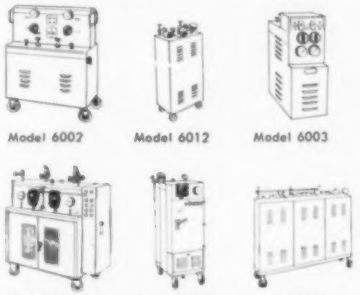


Sterlco®

SINGLE ZONE TEMPERATURE CONTROL FOR INJECTION MOLDING, VACUUM FORMING, EXTRUDING

Model 6012 is especially designed for plastic forming processes where a single, stabilized water temperature is required for the control of mold or calendar roll temperatures. Outstanding features of Model 6012 include fast reaction to temperature change, low water capacity, high circulating velocity. Normal operating position is vertical, but it can be furnished to operate in any one of 4 horizontal positions at no additional charge.

MODELS FOR EVERY PURPOSE



Leaders in temperature control since 1916

Sterling inc.

5202 W. Clinton Ave., Milw., 23, Wis.

Industrial Control Division

tirely eliminates the normal felting process.
The material can be produced with any man-made fibre and is offered in various combinations in widths up to 108 inches, and thicknesses to one inch. Write *Dept. SPE*, **The Felters Co., 210 South St., Boston 11, Mass.**

Special Hardener for Flexible Epoxy Systems

Designed specifically for use with CIBA flexible epoxy resins is a new hardener, Araldite DP-125. Systems employing it can be cured at room or elevated temperature with advantages including low initial viscosity of resin-hardener mix (1000-1500 cps), excellent elongation properties with good tensile strength, and resistance to age hardening (no change after 90 days at room temperature). Recommended by the manufacturer for adhesives, caulking and sealing, electrical potting and impregnating. Write *Dept. SPE*, **CIBA Products Corp., Fair Lawn, N. J.**

EQUIPMENT

Reciprocating Screw Plasticizer

Reciprocating screw injection machines in sizes from 2-oz. through 6, 12, 32, 60, and 120 ozs. produced for the past five years in Germany are now available in the U.S. These machines replace the conventional torpedo cylinder and ram. The design allows the successful molding of heat sensitive materials such as rigid vinyl, ABS, polycarbonates, nylon and fluorinated polymers as well as the more conventional materials. Details from *Dept. SPE*, **Ankerwerk International, Krauss-Maffei International. 1229 E. Wakeham Ave., Santa Ana, Calif.**

High Temperature Plasticimeter

Said to accurately forecast and record plastic properties of materials to 1150°F, "Plasticorder", with temperature uniformity guaranteed by the manufacturer, can be used under typical processing conditions for coal, organo-metals, ceramics and polymers. For complete specifications, *Dept. SPE*, **C. W. Brabender Instruments, Inc., South Hackensack, N. J.**

Economical Mold Chiller

A new, low price model 2 hp Air Cooled Injection Mold Chiller rated at 18,850 BTU can be had immediately. The manufacturer points out that it is the only chiller designed specifically for circulating alcohol type antifreeze to injection mold. Write *Dept. SPE*, **Injection Molders Supply Co., Inc., 17601 South Miles Rd., Cleveland 28, Ohio.**

Compact Injection Molding Machine

A new 3-¾-oz.-speed Injection Molding Machine for all types of plastics is said to combine many exclusive features into one compact unit. Produced by Argyle Engineering Co., this versatile press plasticizes material up to 75 lbs per hour. High capacity combines with low initial and operating costs. Inquiries to *Dept. SPE*, **Bell Machinery Co., Inc., 4439 Santa Fe Ave., Los Angeles 58, Calif.**

Blow Molding Package

A new single station blow molding machine Model 1412S-5 installed with a 2-½-in. 20:1 L/D extruder (Hartig) is said to be ideally suited to laboratory and experimental work on blow molding, and is actually a fast production unit. The new machine has a clamp force of five tons designed for fast platen closing under low pressure prior to final closing Specifications and details, *Dept. SPE*, **Waldron-Hartig Div., Midland-Ross Corp., Box 791, New Brunswick, N. J.**

Digital Set Point Controllers

Adjust a 3-digit, 1000 part dial, and the control point of this new Digital Set Point Controller can be set in increments as small as ½°. Null balance circuit provides measurement sensitivity better than ¼ of 1° with most thermocouples. The manufacturer claims that this new line of compact controllers permits closer accuracy in temperature or other millivolt source control. For specifications, write *Dept. SPE*, **(Bulletin JY) West Instrument Corp., 4363 West Montrose Ave., Chicago 41, Ill.**

200-Ton Automatic Transfer Mold Press

A completely automatic molding operation is possible from the loading of the preforms to the removal of finished molding pieces with a 200-ton automatic transfer molding press, the largest of this design ever built. There's news, too, in the improved flexible, fully-automatic system for feeding preforms into the preheater and moving the heated charge into the molding area, as well as a new combing and ejection system. For information: *Dept. SPE*, **J. F. Stokes Corp., 5300 Tabor Rd., Philadelphia 20, Pa.**

New Feeder-Hopper

A new, completely enclosed, air-powered feeder-hopper combination has been designed for accurate, close control of material flow. With no moving parts coming in contact with material handled, freedom from contamination and dust is possible. The air-powered vibratory drive unit supplies the force to move up to 6000 lbs. of granulars per hour, and it will operate while submerged in liquid. Contact. *Dept. SPE*, **Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland 13, Ohio.**

Vacuum Loading Systems

Four new units have been added to Rainco's line of vacuum loading systems. A new Flake Loader for loading and discharging fluffy or flaking materials; a loader suitable for loading 1200 lbs. per hour of standard pelletized and dry colored materials; a high capacity unit for capacities up to 1800 lbs per hour; and a dust tight model for loading powdered and very dusty dry colored materials. Contact *Dept. SPE*, **The Rainville Co., Inc., 839 Stewart Ave., Garden City, N. Y.**

MANUFACTURERS' LITERATURE

Clad Paper-Plastic

Grades XXP-E and XXP-R copper-clad paper-phenolic laminated plastic which have excellent punching and machining properties are detailed in Technical Data Bulletin No. 3.1.20. Grades GEC-500E copper-clad glass-epoxy laminated plastic featuring low moisture absorption and excellent chemical resistance and mechanical strength is the subject of Bulletin 51.5.12. The bulletins give all specifications and details of use. Write *Dept. SPE*, **Taylor Fibre Co., Norristown, Pa.**

Plastic Labels

Twelve color pages illustrate Marlex plastic labels with all their applications. Send for it from *Dept. SPE*, **Phillips Chemical Co., Bartlesville, Oklahoma.**

1961 Plant Equipment Catalog

Here's an engineering handbook with 72 illustrated pages detailing the standard items of the Injection Molders Supply Co.'s stock items all priced all available immediately. For a copy, *Dept. SPE*, **Injection Molders Supply Co., Inc., 17601 South Miles Rd., Cleveland 28, Ohio.**

For Spray-Up Application

Polyester resins for spray-up applications in construction of boats, furniture, swimming pools, industrial housing etc., are taken up in a new bulletin that includes all the features of the Cyanamid product, Laminac®. Complete instructions for use and specifications with a Catalyst Concentration Chart appear in the booklet, available upon writing to *Dept. SPE*, **American Cyanamid Co., Plastics and Resins Div., Wallingford, Conn.**

PRODUCTION • DEVELOPMENT • RESEARCH •

KILLION *Extruders*

NEW K-100 DUAL PURPOSE EXTRUDER, to be revealed for the first time at the SPI Show, is an excellent machine for producing the new foam styrene sheeting.

THIS NEW DUAL PURPOSE K-100 represents the most modern and up-to-date design in precision extruders. Backed by Killion's 15 years of experience as the world's largest manufacturer of laboratory extruders, the K-100 is engineered to serve the plastic research and development laboratory.

VERSATILITY—The dual purpose K-100 provides the ultimate in versatile extruder design. The complete range of standard accessories that have been designed for the K-100 makes it possible, for the first time, to use one extruder in *all* types of production, research and development programs. Excellent for producing tubing, pellets, coatings, flat and blown films and oriented filaments. With the easily changed, custom-engineered screws and dies developed for the K-100, all plastics materials can be utilized.

DEPENDABILITY—Finger-tip temperature and variable speed control is just one of the features introduced with the K-100 to insure accurate, efficient operation—in *any* type of installation.

DURABILITY—The K-100 features compact, "built-in" construction to insure continuous service—even under the most severe operating conditions.

Call or write for full information on the new K-100 today. It's just one of our complete line of extruders engineered to serve your plastic PRODUCTION, RESEARCH and DEVELOPMENT needs!

STANDARD EQUIPMENT: 1" 20-1 screw • Xaloy barrel • Stainless steel feed section and hopper • 1 HP vari-drive • Gear reducer • Finger tip controls • Electric band heater.

OPTIONAL EQUIPMENT: Water - cooled screws • Air or water cooling on barrel • Pressure gauge • Swing gate.

SAY "HELLO" AT THE SHOW! BOOTH #1622

KILLION
Tool & Manufacturing Company

56 Depot St., Verona, N.J.
Tel: CEnter 9-0200 or 9-0201

"Plastics in Packaging"

Virtually every aspect of "Plastics in Packaging" from film and sheeting to economics and toxicity problems will be discussed at an SPE Regional Technical Conference in Montreal, Quebec on June 14, 1961. The Conference will be sponsored by the Quebec Section at the Sheraton Mount Royal Hotel. The complete program, as announced by Chairman Ralph A. Noble of Canadian Industries, Ltd., includes morning and afternoon technical sessions, luncheon and closing reception.

The technical program numbers ten papers and features such subjects as blow molding and its future applications in packaging, polypropylene film, foam products and skin packaging. Of particular interest will be a paper on the Food and Drug Act and its effect on packaging materials delivered by Dr. R. A. Chapman of the Food and Drug Directorate, Department of National Health and Welfare. Discussions on polyethylene will encompass overwrapping, development of heavy wall shipping bags, economics of thermoformed containers and surface treatment of coatings.

Luncheon speakers at the Conference will be Dr. Norman Rawson, noted Canadian ecclesiastic, and James R. Lampman, SPE Vice-President, Engineering, who will speak on recent progress and goals of the Society. Also an active participant will be Maurice F. Malone, SPE Secretary and first Canadian Officer of the international Society.

The complete technical program announced by Program Co-Chairman James K. McCabe of Monsanto Canada Ltd. and Robert A. Tripp of Canadian General Electric Co. Ltd., follows.

June 14, 1961
Sheraton Mount Royal Hotel
Montreal, Quebec

8:00 a.m.—Registration

9:00 a.m.—12:00 *Morning Session*

"Packaging Materials and the Food and Drug Act."
Dr. R. A. Chapman
Food & Drug Directorate, Department of National Health & Welfare

"Overwrapping with Polyethylene"
E. S. Sanderson
Visking Div., Union Carbide Canada Ltd.

"Development of a Heavy Wall Polyethylene Shipping Bag"
W. J. Planck and C. A. Bryant
Canadian Industries Ltd.

"Surface Treatment of Polyethylene Coated Paper and Paper Board"
S. Leeds
Union Carbide Plastics Co.

"Polypropylene Film"
R. K. Buhr and E. L. Kemp
Canadian Industries Ltd.

12:15 p.m.—*Conference Luncheon*

Speakers: **Dr. Norman Rawson and James R. Lampman,** *SPE Vice-President, Engineering*

2:00 p.m.—5:00 p.m. *Afternoon Session*

"Application of Thin Gauge Sheet Polystyrene Foam"
Ralph Hansen
Monsanto Chemical Co.

"Materials and Techniques for Skin Packaging with Plastics"
R. E. Kostur
Comet Industries Inc.

"Economics of Thermoformed Linear Polyethylene Containers"
P. Quesnel
DuPont Co. of Canada Ltd.

"Blow-Molding"
Staff member of
Phillips Chemical Co.

"Future Uses of the Blow-Molding Process"
R. L. Wechsler
Union Carbide Plastics Co.

5:30 p.m.—*Conference Reception*

Attendees may register in advance on the eve of the Conference, Tuesday, June 13, at the Sheraton Mount Royal Hotel.

Other major Committee Chairmen of the sponsoring Quebec Section include: House, John C. Bonnett of G. M. Plastics Corp.; Publicity, James W. Quarles of Union Carbide Canada Ltd.; Printing, James Storey of B. F. Goodrich Chemical Co.; Treasurer, Marcel Mineau of Industrial Plastics Extrusions; and Secretary, C. Kenneth Dewar of Dominion Rubber Co.

Requests for further information and advance registration should be directed to:
James C. Gillis, *RETEC Registration Chairman*
c/o Carlew Chemicals, Ltd.
18 Westminister St., N., Montreal West, Quebec

NEW

LOMBARD SCREW INJECTION MOLDING MACHINE

. . . OVER TWO YEARS IN DEVELOPMENT.
. . . FULLY TESTED IN ACTUAL OPERATION FOR 16 MONTHS.

MODEL 300-14S

FEATURING —

- Extreme versatility — capable of molding virtually all thermoplastics — from rigid PVC to styrene — without changing screws
- Faster color changes than ever before
- Lower demand on clamping pressure
- Ruggedness and speed never before available

A LOMBARD SCREW INJECTION MOLDER ASSURES YOUR OBTAINING —

- Higher quality parts — virtually strain free
- A more homogeneous melt — extreme accuracy on heat control
- Positive metering of shot weight — no packing
- Greater injection speeds — for thin walled and deep core items

A SCREW INJECTION MACHINE DESIGNED AND BUILT FOR THE AMERICAN MOLDER

INJECTION MOLDING MACHINE DIVISION
LOMBARD GOVERNOR CORPORATION
ASHLAND, MASSACHUSETTS

See us at Booth 811
at the Plastics Show

MORE

Thrust bearing capacity

Gear box capacity

Hopper capacity

Screw design experience

MORE

Quality and Production

HARTIG

technical competence in plastics process machinery

WALDRON-HARTIG, Box 531, Westfield, N. J. / a division of Midland-Ross Corporation MR

TECHNICAL MEETINGS CALENDAR

1961 REGIONAL TECHNICAL CONFERENCES (RETEC)

May 9—Plastics in the Automotive Industry sponsored by Detroit Section with cooperation of Plastics in the Automotive Industry PAG, Detroit Mich. Co-Chairmen: John A. McPherson, c/o Underground Products Inc., 12801 Inkster St., Livonia, Mich., and John J. Doyle c/o Rohm & Haas Co., 20211 Greenfield St., Detroit 35, Mich.

June 14—Plastics in Packaging—Sheraton Mount Royal Hotel, Montreal, Quebec, Canada. Chairman: Ralph Noble, c/o Canadian Industries, Ltd., P.O. Box 10, Montreal, Quebec, Canada.

September 12—Plastics for Tooling sponsored by Central Indiana Section, Hotel Severin, Indianapolis, Ind. Chairman: Eugene C. Quear, c/o Delco-Remy Division, General Motors Corp., 2401 Columbus Ave., Anderson, Ind.

October 5—Plastics Foams sponsored by Buffalo Section. Section President: William Dunmyer, c/o The Carborundum Co., Building 71-1, Buffalo Ave., Niagara Falls, N. Y.

October 25—Plastics in Major Household Appliances sponsored by Kentuckian Section, Monogram Hall, Appliance Park, Louisville, Ky, Chairman: Ray E. Eshenaur, c/o General Electric Company, AP-5-249, Appliance Park, Louisville, Ky.

November 2-3—Plastics in Packaging and Engineering Exhibition on November 1, 2, 3. RETEC sponsored by North Texas Section and Exhibition by Section with cooperation of Southwestern Division Chapter, Society of Packaging and Handling Engineers. Sheraton-Dallas Hotel, Dallas, Tex. Chairman: Peter W. Kent, 3637 Mid Pines Drive, Dallas 29, Texas.

November 15—Vinyl Plastics in the Household sponsored by New York Section with cooperation of Vinyl Plastics PAG, Statler Hilton Hotel, New York, N.Y. Chairman: Saul Gobstein, c/o Ferro Chemical Co., Box 607, Emerson, N. J.

December 1—Plastics Screw Injection Molding sponsored by Cleveland Section, Cleveland Engineering Society Building, Cleveland, Ohio. Chairman: Edward J. Haskins, c/o Injection Molders Supply Co., 17601 South Miles Road, Cleveland 28, Ohio.

Offers of papers for presentation at these Regional Technical Conferences are invited. Please address offers to RETEC Chairman or Section President.

ANNUAL TECHNICAL CONFERENCES (ANTEC)

January 30-February 2, 1962—18th ANTEC, Penn-Sheraton Hotel, Pittsburgh, Pa. Sponsored by Pittsburgh Section. General Chairman: John E. Parks, H.P.M. Division, Koehring Co., 512 Empire Building, Pittsburgh 22, Pa.

January 22-25, 1963—19th ANTEC, Ambassador Hotel, Los Angeles, California. Sponsored by Southern California Section. For information write Executive Secretary Thomas A. Bissell, Society of Plastics Engineers, Inc.

January 28-31, 1964—20th ANTEC, Chalfonte-Haddon Hall, Atlantic City, N. J. Sponsored by Philadelphia Section. For information write Executive Secretary Thomas A. Bissell Society of Plastics Engineers, Inc.

January 18-22, 1965—21st ANTEC, Boston, Mass. Sponsored by Eastern New England Section. For information write Executive Secretary Thomas A. Bissell, Society of Plastics Engineers, Inc.

INTERNATIONAL PLASTICS SHOW

June 21-July 1—International Plastics Exhibition and Convention, Olympia, London, England, Organized by **British Plastics.** Address inquiries to: Interplas '61, Dorset House, Stanford St., London S. E. 1, England.

POLYMER SYMPOSIUM

July 27-August 1, 1961, International Symposium on Macromolecular Chemistry, Montreal, Canada. Address inquiries to: The Organizing Committee International Symposium on Macromolecular Chemistry, P.O. Box 816, Sarnia, Ontario, Canada.

PLASTICS EXHIBITION

June 21-July 1, 1961, Sixth International Plastics Exhibition, organized for British Plastics and International Plastics Engineering by Iliffe Exhibitions Ltd., with the cooperation of the British Plastics Federation. The exhibition will be held in conjunction with the Interplas '61, Olympia, London.

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NEW BOOKS

PROGRESS IN DIELECTRICS—VOLUME TWO

Edited by: J. B. Birks, B.A., Ph.D., D.Sc., F. Inst. P., A.M.I.E.E., J. H. Schulman, PhD. (John Wiley & Sons, Inc., 225 pp., $9.50)

The second book of the Progress in Dielectrics series is a compilation of six articles by different authors reviewing the present state of knowledge in selected aspects of the properties of dielectrics in weak electric fields. The compilation is made up of the following articles:

Theory of Polarization and Absorption in Dielectrics; An Introductory Survey by G. Wyllie;
Dielectric Properties of Polymeric Systems by A. J. Curtis;
Irradiated Polymers by R. M. Black and A. Charlesby;
The Dielectric Properties of Glass;
High-Permittivity Ceramics for Capacitors by K. W. Plessner and R. West; and
Artificial Dielectrics by J. Brown.

The book is well organized and each chapter is clearly written. The diagrams, figures, chemical equations, graphs and surfaces used throughout enhance this endeavor. The compilation is an excellent review and literature source for those persons working in the field of dielectrics.

J. R. Taylor
Research Department,
Monsanto Chemical Co.

PLASTICIZERS

D. N. Buttrey (Franklin Publishing Co., Inc., Palisade, N. J., 1960, 213 pp. $7.50)

This second edition, revised and enlarged, is definitely up to date. The reader will obtain from this concise textbook complete data on the nature, chemical properties, physical characteristics and uses of plasticizers manufactured and available in this country and abroad.

It is divided into 12 chapters dealing with phtalate esters, phosphoric acid derivatives, the glycero-glycol group and esters: alkyl, aryl, lauric, palmitic and many others. Further on, we find toluene and diphenyl derivatives, camphor, phenol derivatives, resins, waxes, hydrocarbons and the most recent phtalates and esters.

Each chemical has its own monograph and its properties are summarized in tables which add value to the text itself. An index of these 94 tables makes it easy and quick to find at a glance the characteristics of each plasticizer. There is also a bibliography and a substance index. You will probably have many occasions to consult "Plasticizers".

Dr. Louis C. Barail
Barail Associates

MANIPULATION OF THERMOPLASTIC SHEET, ROD & TUBE

by J. M. J. Estevez and D. C. Powell (from I.C.I., in England). (Interscience Publishers New York, and Iliffe & Sons (London, 1960. 148 pp., $4.85)

This book fulfills its purpose quite well, as a text for students at the British Plastics Institute. It is unfortunate, perhaps, that we in America have few real students of specialized fields such as this. However, the book may well have other uses—as an introductory manual for newcomers to the sheet-fabrication industry, or as concentrated training for salesmen calling on that industry. Those already familiar with sheet-forming might at least learn a few new methods in use in the United Kingdom, but not here. The reasonable cost and specialized subject matter help to make it a worthwhile addition to the available plastics literature.

Some of the topics discussed include: different kinds of heating ovens, how different materials stretch under heat, suggested adhesives, uses of hydraulic and mechanical pressure to form hot sheet, principles of good design of both objects and molds, and typical properties of common sheet materials (useful only as a general guide). The stress on design is particularly commendable. High-impact polystyrene, so important in the U.S., is somewhat neglected, but not forgotten, particularly as many of the general principles apply to all materials.

Allan L. Griff
Technical Service Dept.
Union Carbide Plastics Co.

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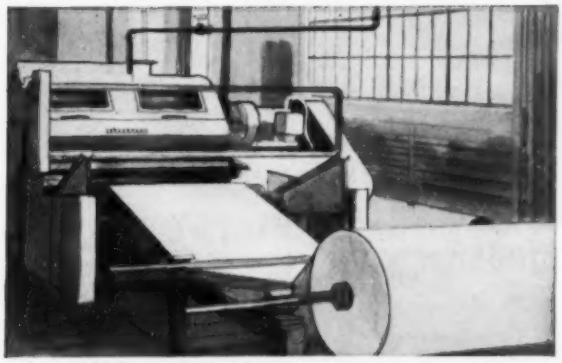

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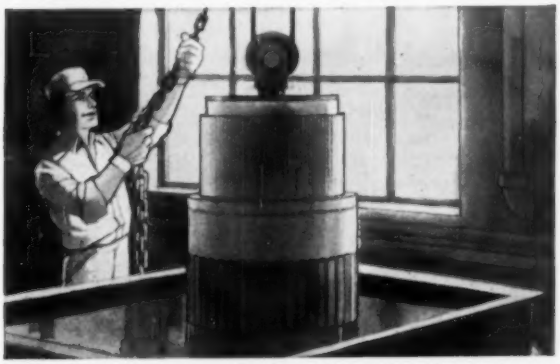

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Employment & Service Guide

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Opening in metropolitan area for man with practical experience relating to plastic compounding machinery. Job involves new installation design, improvement of existing processing methods, maintenance and supervision. All replies held in strictest confidence. Send reply with salary requirements to Box No. 218, SPE JOURNAL.

PLASTICS DEVELOPMENT ENGINEER

We have an attractive opening in our New Product Development Dept. for an engineer or chemist to work on fabrication techniques for new thermoplastics. B.S. minimum, 3-10 years broad experience in fabrication of plastics, especially extrusion. Send resume in confidence to Dr. David M. Clark, Director of Technical Recruiting, W. R. Grace & Co., Research Division, Clarksville, Md.

FIELD ENGINEER-PLASTIC EXTRUSION

Attractive opening for a man with plastic extrusion experience to service extrusion accounts. If you have a flair for meeting people and helping to solve their technical problems and enjoy traveling, submit your resume today. An Engineering Degree is helpful but you can qualify based on experience in plastic extrusion production.

Write in confidence to:

N. H. Petersen, Placement Manager

MARBON CHEMICAL DIVISION
Borg-Warner Corporation
P. O. Box 68
Washington, West Virginia

SALES REPRESENTATIVE WANTED

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Expanding operations require experienced graduate chemist for product application and development on stabilizers for Polyvinyl-chlorides compositions.

Send complete resume to
Director of Research & Development

NUODEX PRODUCTS DIV.
1075 Magnolia Ave., Elizabeth, N. J.

SALES REPRESENTATIVES

Wanted by growing machine manufacturer for complete line of blow-molding machines, heating cylinders, injection nozzles, parts and special plastic processing equipment, U.S. and Canada. Sales experience and technical knowledge required. Non-competitive sidelines considered. Protected districts, excellent opportunities, high earnings. Atlas Molding Machine Corp., div. of Atlas Machine & Tool Corp., 257-259 Hackensack St., East Rutherford, N. J.

REXALL CHEMICAL COMPANY
DIVISION OF REXALL DRUG & CHEMICAL COMPANY

Current operations of the Rexall Chemical Company are expanding rapidly and growth employment opportunities for technical personnel exist in most of the following functions and geographical locations.

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(Under Construction)

POLYSTYRENE
Holyoke, Massachusetts
Santa Ana, California
Midwest — (Being Designed)

FINE CHEMICALS
Kearny, New Jersey

ENGINEERING
Los Angeles, California

PROCESS DESIGN

PROJECT ENGINEERING

ECONOMICS AND PLANNING

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RESEARCH & DEVELOPMENT
Paramus, N.J.,
(Nearing Completion)

BASIC & DEVELOPMENT RESEARCH — POLYMERS
Scouting Research
Development Research
Analytical
Pilot & Semi-Commercial Plants
Bench Scale Pilot Plants

SALES SERVICE
Application Research
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RESUMES SHOULD BE SENT TO...

THE ADMINISTRATIVE DIRECTOR, A. B. WINTRINGHAM, 8480 BEVERLY BLVD., LOS ANGELES 54, CALIFORNIA

POSITIONS WANTED

PLASTICS, METALS, PRINTED-CIRCUITS

Both Management and Technical experience in Prototype research, development and limited production for Electronic, Structural and Aerospace Projects. Very heavy experience in Plastics Materials and Processes. Proposal preparation, fabrication specifications and Technical Consultation. Age 32, happy to relocate and travel. Resume available. Box No. 191, SPE JOURNAL.

ENGINEERING EXECUTIVE

Twenty years experience in molding, finishing and tool design. Successful management record in research and development, engineering, production and sales. Desires challenging managerial position with opportunity to grow. Married, family, will relocate. Broad experience in planning and building special facilities and organization. Box No. 215, SPE JOURNAL.

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Knows business from coveralls to white shirt. Unusual combination of technical skill and business management. Can operate in plant or out. Both desk and factory man. Can relieve owner or president of day to day operational duties. Can train personnel, institute systems and organization either in existing or projected plant. Box. No. 214, SPE JOURNAL.

SALES PLANNING, PROMOTION

Find out how this chemical engineer's creative approach to marketing problems can help you sell more plastics materials, equipment, or products. Whether your problem concerns a new product or an old one, he can help you. Write Box 175, SPE JOURNAL, 65 Prospect St., Stamford, Conn.

CHALLENGING POSITION

desired in plastics or related field. 19 years diversified experience. Lab. Dir., industrial research, development, process and product improvement, quality control, evaluation; thermoplastics, granuplasts, thermosets, finishes, special effects, colors, fastenings; injection, compression molding. B. S. Chemistry. Will relocate. Travel some. Resume. Box No. 225, SPE JOURNAL.

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Eight years solid experience in lab, plant and technical sales; one year sales experience. Thorough knowledge extrusion, plastisol molding and coating, adhesives, inks and dispersions, laminations. Strong, diversified technical background presents very positive plus for versatile, mature, intelligent representation in Chemical Sales directed to plastics field. Box No. 217, SPE JOURNAL.

SUPERINTENDENT-PLASTICS ENGINEER

Two man team capable of organizing and operating either new or existing molding operation. Over 15 years each in injection, compression and transfer molding of precision parts. Experience includes tool design, cost estimating, sales and customer contact. Wish to locate on West Coast. Box No. 222, SPE JOURNAL.

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Thermoplastics Technical Service Manager in charge of injection molding, extrusion, and sheet forming activities, desires similar managerial position on eastern seaboard. Interested in marketing or development middle management. Box No. 216, SPE JOURNAL.

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Age 30: 7 years a diemaker of plastic molds and die-cast dies, 2 years a junior executive manufacturing these tools, one year on design of these tools. Willing to work for a nominal salary in return for an opportunity to learn the molding business. Detroit and Michigan area first choice. Resume on request. Box No. 213, SPE JOURNAL.

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With successful thermoplastic experience, seeks more challenging opportunity. Can handle problems in applications, development and sales service. New ideas that can pay off for you. Résumé on request. Strictest confidence. Box No. 221, SPE JOURNAL.

MANAGEMENT OR ENGINEERING

20 years of engineering and managerial experience in injection and compression plants. Engineering includes product development, customer contact, mold and tool design and procurement. Proven ability to organize, plan and direct. Box No. 224, SPE JOURNAL.

PLASTICS ENGINEER

Age 55; family. 19 years experience covering compression, transfer, plunger, lamination, extrusion, injection molding and electronic heat sealing. Currently running multi-cavity hot runner and insulated runner molds on fully automatic operation. New England location desired. Box No. 223, SPE JOURNAL.

CLASSIFIED RATES

"Position Open" and "Position Wanted"—$12.50 per column inch, 2¼ inches wide. (35 characters per line; 7 lines per inch). Minimum charge: $12.50. "Products and Services"—$20.00 per inch. Minimum charge: $20.00.

All ads include one bold face caption line. Additional caption lines at $2.50 extra per line. Boxed ads (four side rules) $3.00 additional charge. Agency commission allowed *only* on ads five inches or more in depth. Display ads of 1/6 page or more are charged at regular advertising space rates. Typesetting (non-commissionable) will be charged as cost.

SPE members in good standing are entitled to a total of three no-charge "Position Wanted" advertisements during any twelve month period, each ad not to exceed 50 words, headline not to exceed 3 words.

Last day for inserting ads is the first day of the month preceding date of publication. Employers please note: The SPE Journal does not have resumes on file. These must be requested from the applicant.

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Injection compression transfer, quality molds, good delivery, competitive prices. Tested before delivery, laid down in your plant. Steel Dies & Moulds Ltd., 43 Raleigh Ave., Toronto, Canada. PH. AM 1-7092

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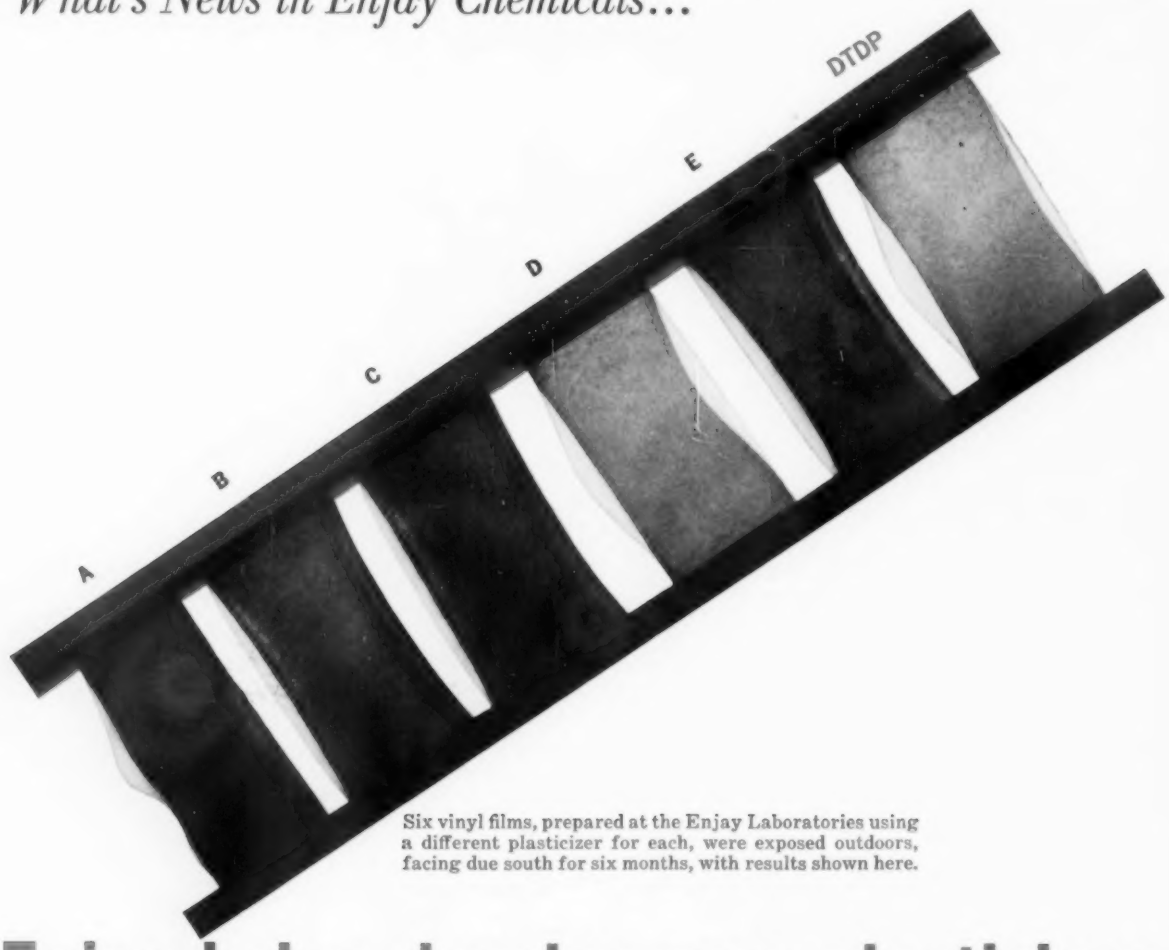
What's News in Enjay Chemicals...



Six vinyl films, prepared at the Enjay Laboratories using a different plasticizer for each, were exposed outdoors, facing due south for six months, with results shown here.

Enjay helps develop new plasticizer for vinyl film and sheeting...

As a service to plastic manufacturers, the Enjay Laboratories have just completed a broad evaluation and testing program on the use of ditridecyl phthalate—DTDP—as a plasticizer for vinyl film and sheeting.

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